This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

LANE MEDICAL LIBRARY STANFORD
2 45 0061 4715

PTON,
KSELLER,
HOLBORN,
DON, W.C.

[illegible]

[illegible]

420

£3..0..0

LANE
MEDICAL LIBRARY
1885
Gift
San Francisco
County Medical Library

THE

ELEMENTS

OF

MATERIA MEDICA

AND

THERAPEUTICS.

BY

JONATHAN PEREIRA, M.D. F.R.S. & L.S.

FELLOW OF THE ROYAL COLLEGE OF PHYSICIANS IN LONDON:
ASSOCIATE OF THE COLLEGE OF PHYSICIANS OF PHILADELPHIA:
HONORARY MEMBER OF THE PHARMACEUTICAL SOCIETIES OF GREAT BRITAIN, ST. PETERSBURG,
AND PORTUGAL; OF THE PHYSICO-MEDICAL SOCIETY OF ERLANGEN;
AND OF THE ASSOCIATION OF HESSIAN PHYSICIANS:
CORRESPONDING MEMBER OF THE SOCIETY OF PHARMACY OF PARIS:
EXAMINER IN MATERIA MEDICA AND PHARMACY TO THE UNIVERSITY OF LONDON:
PROFESSOR OF MATERIA MEDICA TO THE PHARMACEUTICAL SOCIETY:
AND PHYSICIAN TO THE LONDON HOSPITAL.

Fourth Edition,
ENLARGED AND IMPROVED,
INCLUDING
NOTICES OF MOST OF THE MEDICINAL SUBSTANCES IN USE IN THE
CIVILIZED WORLD,
AND FORMING AN
Encyclopædia of Materia Medica.

VOL. I.

LONDON:
PRINTED FOR
LONGMAN, BROWN, GREEN, AND LONGMANS,
PATERNOSTER ROW.
1854.

LONDON:
WILSON AND OGILVY,
Skinner Street.

[illegible]
023
v.1
1854

PREFACE

TO THE FOURTH EDITION

In presenting to the profession the fourth edition of the first volume of the *Elements of Materia Medica* of the late Dr. Pereira, the editors have endeavoured to carry out the plan of the author, by introducing in a concise form a selection of the most important and most recent additions to this branch of medical science. The rapid sale of the second part of the second volume is a satisfactory indication that their efforts to maintain the character of this valuable work have been so far successful.

In adopting the language of the author in his preface to the third edition, the editors take leave to remark, that many portions of the volume have been entirely re-written, some have been curtailed, others enlarged, and every part has been carefully corrected and, it is believed, much improved. Recent discoveries in natural history, chemistry, physiology, and practical medicine, relating to the MATERIA MEDICA, have been introduced into this edition, which, it is believed, will be found to contain a faithful outline of the present state of pharmacological knowledge. The views and opinions of the author have been in no case interfered with. The additions made by the editors have been introduced in brackets.

The numerous changes made in the London and Dublin Pharmaco-

95C36

ce the publication of the former edition, have been duly n short, the editors have had in view the desire of the author, his work an *Encyclopædia of Materia Medica*, and they have ed to make it, as it has hitherto proved, a safe and useful he pharmaceutist and the medical practitioner.

ALFRED SWAINE TAYLOR.
GEORGE OWEN REES.

DON, *Nov.* 7, 1854.

CONTENTS OF VOL. I.

PAGE

Title .. i
Preface .. iii
Table of Contents in Vol. I. .. v
List of Woodcuts in Vol. I. .. xxi

PROLEGOMENA. .. 1

Definitions .. 1

PART I.—PSYCHICAL OR MENTAL REMEDIES. 2

1. External affections of the mind (sensations) .. 2
2. Internal affections of the mind .. 5
    1. The feelings .. 5
    2. The intellect .. 6

PART II.—PHYSICAL BUT IMPONDERABLE REMEDIES. 7

1. Light .. 7
    1. Darkness .. 9
    2. Dioptric instruments .. 9
    3. Chromatic instruments .. 10
2. Heat .. 11
    1. Radiant Heat .. 15
        a. Solar heat .. 15
        b. Artificial radiant heat .. 15
    2. Conducted heat .. 15
        a. Dry heat .. 15
            1. Hot air-bath .. 15
            2. Solid substances heated not above 100° .. 16
            3. Metal heated to 212° .. 17
            4. The actual cautery .. 17
        b. Moist heat .. 17
            a. Aqueous vapour .. 17
            1. The vapour bath .. 17
            2. The inhalation of warm vapour .. 19
            3. Steam .. 20
            b. Warm liquids and moist solids .. 20
            1. Tepid, warm, and cold baths .. 20
            2. Warm affusion .. 22
            3. Warm fomentation and poultices .. 22
            4. Warm aqueous drinks and injections .. 22
            5. Boiling water .. 23

PAGE
.. .. 23
by radiation 28
by evaporation 28
by conduction 28
Cold air 28
Cold liquids 28
. used externally 28
1. Cold bath 29
2. Cold affusion 29
3. Shower bath 31
4. Douche 31
5. Washes 33
. used internally 33
1. Cold drinks 33
2. Cold injections 34
Hydropathy 34
Cold solids: ice and snow 34
1. External use 34
2. Internal use 35
.. .. 35
onal electricity 50
ic electricity 53
o-puncture 56
etic electricity 56
l machines 56
gneto-electric machines 58
.. .. 58

PART III.—HYGIENIC REMEDIES. .. 62

.. .. 62
ical elements 62
ntary principles 63
ound aliments 65
Solid Foods 65
Liquid foods or drinks 67
Condiments 68
.. .. 68
.. .. 70
omena of climates 70
tes used as therapeutical agents 74
es for which change of climate is employed 80

IV.—MECHANICAL AND SURGICAL REMEDIES. 82

ART V.—PHARMACOLOGICAL REMEDIES. .. 82

.. .. 82

Div. I.—General Pharmacology. 83

scertaining the effects of medicine 83
es of medicines 89
fected in medicines by the organism 91

PAGE
. Physiological effects of medicines .. 93
  1. Nature or quality of the effects .. 94
    α. Brunonian theory .. 99
    β. Doctrine of contra-stimulus .. 100
  2. Locality or seat of the effects .. 102
  3. Absorption of medicines .. 103
  4. Operation of medicines by nervous agency .. 117
  5. Circumstances which modify the effects .. 119
. Therapeutical effects of medicines .. 123
  Mode of production .. 123
  Fundamental methods of cure .. 124
    Antipathia .. 124
    Homœopathia .. 125
    Allopathia .. 127
. Parts to which medicines are applied .. 130
. Classification of medicines .. 137
  1. Empirical arrangements .. 137
  2. Rational arrangements .. 138
    α. Classifications founded on the sensible qualities .. 139
    β. Classifications founded on the natural-historical properties 140
    γ. Classifications founded on the chemical constituents .. 147
    δ. Classifications founded on the physiological effects .. 149
      1. according to the general quality of the effects .. 149
      2. according to Brunonian principles .. 154
      3. according to the doctrine of contra-stimulus .. 154
      4. according to the doctrine of Broussais .. 155
      5. according to chemico-physiological principles .. 155
      6. according to the part affected .. 155
    ε. Classifications founded on therapeutical properties .. 157
(*bis*). Physiological classes of medicines .. 158
  Class I. Topical remedies acting mechanically, p. 158
    mechanical antidotes .. 158
    mechanical purgatives and anthelmintics .. 159
    dentifrices .. 159
  Class II. Topical remedies acting chemically, p. 160
    caustics .. 161
    astringents .. 162
    chemical antidotes .. 163
    disinfectants .. 166
  Class III. Topical remedies acting dynamically, p. 168
    acrids .. 168
    emollients .. 170
  Class IV. Hæmatics, or remedies acting on the blood p. 172
    α. physically p. 172
      diluents .. 172
      inspissants .. 173
    β. chemically p. 173
      spanæmics, or impoverishers of the blood .. 173
        α. thirst-quenching and refrigerant .. 174
        β. resolvents or liquefacients 179
          1. alkalines .. 180
          2. salines .. 182
          3. iodics and bromics . 186
          4. sulphurosa .. 187
        γ. antispasmodics .. 189
        δ. plumbeous or saturnine . 190
      hæmatinics, or enrichers of the blood .. 193
    γ. dynamically .. 199

PAGE

- Class V. Pneumatics, or remedies acting on the organs of respiration p. 199
  - affecting the muscles of respiration .. 199
  - affecting the aërian membrane .. 200
  - diminishing the want of breath .. 200
  - influencing the calorific functions .. 201
    - refrigerants 202
- Class VI. Neurotics, or remedies acting on the nervous system p. 203
  - 1. cerebro-spinals p. 204
    - 1. affecting the mind; phrenics .. 204
    - 2. affecting sensibility; æsthetics .. 208
      - α. heightening it; hyperæsthetics 208
      - β. lowering it; anæsthetics .. 208
    - 3. affecting voluntary and reflex spinal movements; cinetics .. 211
      - α. affecting the tonicity of muscles 211
        - αα. augmenting it; tonics 211
        - ββ. depressing it; relaxants 216
      - β. affecting the irritability of muscles 216
        - αα. augmenting it; spastica 216
        - ββ. diminishing it; paralytica 217
      - γ. affecting volition 217
      - δ. affecting the reflex-spinal functions 218
    - 4. affecting sleep; hynics 219
      - α. causing it; hypnotics .. 219
      - β. preventing it; agrypnotics .. 219
    - action of the cerebro-spinals .. 219
    - mode by which they kill 220
  - 2. ganglionics p. 221
    - 1. affecting the heart and arteries .. 222
      - α. exciting them; stimulants .. 222
        - αα. ethereo-oily vegetables 224
        - γγ. resinous 227
        - ββ. ammoniacal and empyreumatic 230
        - δδ. animal excretions .. 231
        - εε. phosphorus .. 231
        - ζζ. spirituous and ethereal 232
      - β. Depressing them; sedantia .. 232
    - 2. affecting the alimentary canal .. 233
- Class VII Cœliacs, or remedies acting on the digestive organs p. 233
  - 1. enterics 233
    - anthelmintics 234
  - 2. hepatics 238
  - 3. splenics 238
  - 4. sialics and pancreatics 239
- Class VIII. Eccritics, or remedies acting on the excernent system p. 239
  - 1. augmenting secretion
    - 1. errhines 240
    - 2. expectorants 241
    - 3. emetics 243
    - 4. cathartics 246
    - 5. diaphoretics .. 251
    - 6. sialogogues 254
    - 7. cholagogues .. 255
    - 8. diuretics 256
  - 2. diminishing secretion 260
  - 3. altering the quality of the secretions . 262
    - lithics 262

PAGE
Class IX. Genetics, or remedies acting on the sexual organs .. p. 268
affecting the orgasm 268
aphrodisiacs 269
anaphrodisiacs 269
affecting the uterus 269
emmenagogues 269
ecbolics 270

Div. II.—Special Pharmacology. 271

I.—INORGANIC BODIES.

Order I.—Oxygen and its Aqueous Solution 272

1. Oxygenium 272
    1. *Aqua oxygenii* 277
    2. *Ozone* 277

Order II.—Hydrogen and its Compounds with Oxygen .. 279

2. Hydrogenium 279
    Aqua hydrogenii 282
3. Aqua 282
    1. *Aqua destillata* 288
    2. *Aquæ medicatæ* 289
    3. *Infusa* 289
    4. *Decocta* 290
    Division of natural waters 290
    1. Aquæ communes 290
        1. *Aqua pluvialis* 297
        2. *Aqua fontana* 298
        3. *Aqua ex puteo* 298
        4. *Aqua ex flumine* 299
        5. *Aqua ex lacu* 301
        6. *Aqua ex palude* 301
    2. Aqua marina 301
        Balneum maris factitium 303
    3. Aquæ minerales 303
        Class 1. Chalybeate or ferruginous waters 305
            Order I. Carbonated chalybeates 307
            Order II. Sulphated chalybeates 307
        Class 2. Sulphureous or hepatic waters 308
        Class 3. Acidulous or carbonated waters 309
        Class 4. Saline waters 311
            Order I. Purging saline waters 311
            Order II. Salt or brine waters 312
            Order III. Calcareous waters 312
            Order IV. Alkaline waters 313
            Order V. Siliceous waters 313
            Artificial mineral waters 316
4. Hydrogenii binoxydum 317

Order III.—Carbon and Carbonic Acid 317

5. Carbon 317

PAGE
bago 318
o ligni 320
Cataplasma carbonis ligni 322
o animalis 322
Carbo animalis purificatus 326
acid 327
Aqua acidi carbonici 333

IV.—Boron and Boracic Acid 335

oracicum 335

V.*—Silicon and Silicic Acid 979

silicicum 979

V.—Phosphorus and Phosphoric Acid 340

us 340
1. *Amorphous* 980
2. *Tinctura phosphori ætherea* 345
3. *Oleum phosphoratum* 346
hosphoricum 346

VI.—Sulphur, and its Compounds with Oxygen, Hydrogen, and Carbon 350

.. .. 350
1. *Sulphur sublimatum* 356
2. *Sulphur præcipitatum* 357
3. *Unguentum sulphuris* 358
4. *Unguentum sulphuris compositum* 358
5. *Oleum sulphuratum* 358
6. *Sulphur vivum* 359
sulphuricum 359
1. *Acidum sulphuricum dilutum* 372
2. *Acidum sulphuricum aromaticum* 373
sulphurosum 373
hydrosulphuricum 375
Aqua acidi hydrosulphurici 376
bisulphuretum 377

VII.—Chlorine, and its Combinations with Hydrogen and Sulphur 379

um 379
1. *Aqua chlorinii* 385
2. *Liquor chlorinii* 980
hydrochloricum 387
seous hydrochloric acid 387
atery hydrochloric acid 390
Acidum hydrochloricum dilutum 395
s dichloridum 396

PAGE
ORDER VIII.—IODINE, AND ITS COMBINATIONS WITH OXYGEN, HYDROGEN, SULPHUR, AND CARBON .. 396

18. Iodinium .. .. .. (also Appendix, p. 980) 396
  1. *Tinctura iodinii* 410
  2. *Embrocatio iodinii* 411
  3. *Iodidum amyli* 411
  4. *Unguentum iodinii* 412
  5. *Unguentum iodinii compositum* 412
  6. *Emplastrum iodinii* 412
19. Acidum iodicum 412
20. Acidum hydriodicum 413
21. Sulphuris iodidum .. .. .. (Appendix, p. 981) 413
  1. *Unguentum sulphuris iodidi* 414
  2. *Sulphuris iodatum* 981
22. Iodinii chloridum 414

ORDER IX.—BROMINE 415

23. Brominium 415

ORDER X.—NITROGEN, AND ITS COMPOUNDS WITH OXYGEN AND HYDROGEN 418

24. Nitrogenium 418
25. Nitrogenii protoxydum 419
  Aquæ nitrogenii protoxydi 421
26. Nitrogenii binoxydum 422
27. Acidum nitricum 422
  Liquid or watery nitric acid 423
  1. *Acidum nitricum dilutum* 430
  2. *Unguentum acidi nitrici* 431
28. Acidum nitro-hydrochloricum 432
  Balneum nitro-hydrochloricum 433
29. Ammonia 433
  1. Gaseous ammonia 434
  2. Aqua ammoniæ 437
    1. *Linimentum ammoniæ* 445
    2. *Linimentum ammoniæ compositum* 445
    3. *Unguentum ammoniæ* 446
    4. *Tinctura ammoniæ composita* 446
    5. *Spiritus ammoniæ* 446
30. Ammoniæ carbonates 447
  1. Ammoniæ monocarbonas 449
    1. *Spiritus ammoniæ fœtidus* 450
    2. *Spiritus ammoniæ aromaticus* 450
  2. Ammoniæ sesquicarbonas 451
    1. *Liquor ammoniæ sesquicarbonatis* 457
    2. *Linimentum ammoniæ sesquicarbonatis* 457
    3. *Ammoniæ sesquicarbonas pyro-oleosa* 457
  3. Ammoniæ bicarbonas 457
31. Ammoniæ hydrochloras 458
  1. *Lotio ammoniæ hydrochloratis* 465
  2. *Emplastrum ammoniæ hydrochloratis* 465

PAGE
niæ hydrosulphates .. 465
Ammoniæ bihydrosulphas .. 465
Boyle's fuming liquor of sulphur .. 468
niæ sulphas .. 470
niæ nitras .. 470
niæ acetas .. 471
niæ citras .. 473
niæ tartras .. 473
niæ oxalas .. 474
.. 474

r XI.—POTASSIUM AND ITS COMPOUNDS .. 478

um .. 478
.. 478
Liquor potassæ .. 484
Potassæ hydras .. 486
Potassa cum calce .. 488
e carbonates .. 488
Potassæ monocarbonas .. 488
Liquor potassæ carbonatis .. 494
Potassæ bicarbonas .. 494
1. *Potassæ aqua efferrescens* .. 497
2. *Lemon and kali* .. 498
i tersulphuretum .. 498
Solutio potassii sulphureti .. 501
Balneum sulphuratum .. 501
Balneum sulphuratum et gelatinosum .. 501
e sulphates .. 502
Potassæ monosulphas .. 502
Potassæ sulphas cum sulphure .. 505
Potassæ sesquisulphas .. 505
Potassæ bisulphas .. 506
i chloridum .. 508
e hypochloris .. 508
e chloras .. 509
i iodidum .. 513
1. *Unguentum potassii iodidi* .. 521
2. *Unguentum iodinii compositum* .. 522
3. *Tinctura iodinii composita* .. 522
4. *Liquor potassii iodidi compositus* .. 522
5. *Emplastrum potassii iodidi* .. 522
6. *Solutiones potassii superiodidi* .. 523
7. *Balneum potassii superiodidi* .. 523
i bromidum .. 524
Unguentum potassii bromidum .. 527
i cyanidum .. 527
i ferrocyanidum .. 530
i ferridcyanidum .. 534
e nitras .. 535
Inhalatio nitrosa .. 545
e acetas .. 546
e tartrates .. 548
Potassæ tartras .. 548

PAGE
2. Potassæ tartras acida .. 550
  1. *Potus imperialis* .. 553
  2. *Serum lactis tartarisatum* .. 553
56. Potassæ boro-tartras .. 553
57. Potassæ citras .. 553
58. Potassæ oxalates .. 554
  1. Potassæ monoxalas .. 554
  2. Potassæ binoxalas .. 554
  3. Potassæ quadroxalas .. 555

ORDER XII.—COMPOUNDS OF SODIUM .. 555

59. Soda .. 555
60. Sodæ carbonates .. 556
  1. Sodæ monocarbonas .. 556
    Sodæ carbonas exsiccata .. 562
  2. Sodæ sesquicarbonas .. 562
  3. Sodæ bicarbonas .. 564
    1. *Pulveres effervescentes* .. 568
    2. *Pulveres effervescentes citrati* .. 568
    3. *Pulveres sedlitzenses* .. 568
    4. *Aqua sodæ effervescens* .. 569
    5. *Sodæ carbonatis liquor* .. 569
    6. *Trochisci sodæ bicarbonatis* .. 569
61. Sodæ biboras .. 569
    Mel boracis .. 573
62. Sodæ phosphas .. 574
    Solutio sodæ phosphatis .. 577
63. Sodæ hyposulphis .. 577
64. Sodæ bisulphis .. 578
65. Sodæ sulphas .. 579
66. Sodii chloridum .. 580
    Enema commune .. 589
67. Sodæ hypochloris .. 589
    1. *Gargarisma sodæ chlorinatæ* .. 594
    2. *Lotio sodæ chlorinatæ* .. 594
    3. *Injectio sodæ chlorinatæ* .. 594
    4. *Cataplasma sodæ chlorinatæ* (Appendix, p. 981) 594
68. Sodæ nitras .. 594
69. Sodæ acetas .. 596
70. Sodæ valerianas .. 597
71. Sodæ tartras .. 597
72. Potassæ et sodæ tartras .. 597
73. Sapones sodaici et potassici .. 599
    1. *Linimentum saponis* .. 605
    2. *Ceratum saponis* .. 605
    3. *Emplastrum saponis* .. 605
    4. *Emplastrum resinæ* .. 606

ORDER XIII.—COMPOUNDS OF LITHIUM .. 606

74. Lithiæ carbonas .. 606

PAGE
XIV.—Compounds of Barium 607
xydum 607
carbonas 608
sulphas 609
loridum 610
Liquor barii chloridi 614
didum 614
nitras 614
Solutio barytæ nitratis 615

XV.—Compounds of Calcium 615
.. .. 615
1. *Liquor calcis* 619
2. *Linimentum calcis* 619
arbonates 619
alcis carbonas 620
1. *Mistura cretæ* 624
2. *Pulvis cretæ compositus* 624
3. *Trochisci cretæ* 624
4. *Camphorated cretaceous tooth-powder* 624
alcis bicarbonas 625
riphosphas 625
hloridum 628
or calcii chloridi 630
ypochloris .. .. (Appendix, page 981) 631
1. *Calcis chlorinatæ liquor* 641
2. *Lotio calcis chlorinatæ* 641
3. *Gargarisma calcis chlorinatæ* 641
4. *Dentifricium calcis chlorinatæ* 641
5. *Enema calcis chlorinatæ* 641
6. *Unguentum calcis chlorinatæ* 642
7. *Trochisci calcis chlorinatæ* 642

XVI.—Compounds of Magnesium 642
ia 642
iæ carbonates 647
agnesiæ subcarbonas hydrata 647
Trochisci magnesiæ 654
agnesiæ bicarbonas 654
iæ sulphas 655
1. *Pulvis salinus compositus* 659
2. *Enema catharticum* .. (Appendix, page 982) 659
iæ citras 659
iæ tartras 660

XVII.—Compounds of Aluminum 660
.. .. 660
luminæ hydras 660
rræ aluminosæ 661

PAGE
92. Alumen potassicum .. 662
    1. *Alumen exsiccatum* .. 670
    2. *Liquor aluminis compositus* .. 670
    3. *Pulvis aluminis compositus* .. 670
93. Alumen ferricum .. 670
94. Aluminæ acetas .. 671

ORDER XVIII.—COMPOUNDS OF CHROMIUM .. 671

95. Acidum chromicum .. 671
96. Potassæ chromates .. 672
    1. Potassæ chromas .. 672
    2. Potassæ bichromas .. 673

ORDER XIX.—COMPOUNDS OF MANGANESE .. 674

97. Manganesii binoxydum .. 674
98. Manganesii carbonas .. 676
99. Manganesii sulphas .. 677
100. Manganesii chloridum .. 679
101. Manganesii acetas .. 680
102. Potassæ permanganas .. 680

ORDER XX.—ARSENIC AND ITS COMPOUNDS .. 681

103. Arsenicum .. 681
104. Acidum arseniosum .. 682
    1. *Liquor potassæ arsenitis* .. 718
    2. *Liquor arsenici chloridi* .. 719
    3. *Arsenici et hydrargyri hydriodatis liquor* .. 721
    4. *Pilulæ asiaticæ* .. 721
    5. *Unguentum arsenici* .. 721
    6. *Pasta arsenicalis* .. 721
105. Arsenici sulphureta .. 721
    1. Arsenici bisulphuretum .. 721
    2. Arsenici tersulphuretum .. 722
106. Arsenici teriodidum .. 722
    Arsenici superiodidum .. 723

ORDER XXI.—ANTIMONY AND ITS COMPOUNDS .. 723

107. Antimonium .. 723
108. Antimonii teroxydum .. 724
109. Pulvis antimonii compositus .. 727
110. Antimonii tersulphuretum .. 731
    1. Antimonii tersulphuretum crystallisatum .. 731
        Antimonii sulphuretum præparatum .. 733
    2. Antimonii tersulphuretum amorphum .. 734
        α. Kermes minerale .. 734
        β. Antimonii tersulphuretum præcipitatum .. 734
111. Antimonii pentasulphuretum .. 739
112. Antimonii terchloridum .. 740
    Antimonii terchloridi liquor .. 741

PAGE
113. Antimonii et potassæ tartras .. 741
    1. *Vinum antimonii potassio-tartratis* .. 756
    2. *Unguentum antimonii potassio-tartratis* .. 756

ORDER XXII.—BISMUTH AND ITS COMPOUNDS .. 757

114. Bismuthum .. 757
115. Bismuthi nitras .. 758

ORDER XXIII.—ZINC AND ITS COMPOUNDS .. 761

116. Zincum .. 761
117. Zinci oxydum .. 763
    1. *Unguentum zinci* .. 766
    2. *Zinci oxydum impurum* .. 766
118. Zinci carbonas .. 766-68
    1. *Calamina præparata* .. 768
    2. *Ceratum calaminæ* .. 768
    3. *Ceratum zinci carbonatis* .. 769
119. Zinci sulphas .. 769
120. Zinci chloridum .. 772
    Zinci chloridi liquor .. 775
121. Zinci acetas .. 776
122. Zinci valerianas .. 777
123. Zinci cyanidum .. 777

ORDER XXIV. CADMIUM AND ITS COMPOUNDS .. 778

124. Cadmium .. 778
125. Cadmii sulphas .. 778

ORDER XXV.—TIN AND ITS COMPOUNDS .. 779

126. Stannum .. 779
    Stanni pulvis .. 780
127. Stanni bisulphuretum .. 781
128. Stanni chloridum .. 781

ORDER XXVI.—LEAD AND ITS COMPOUNDS .. 781

129. Plumbum .. 781
130. Plumbi oxydum .. 790
    1. *Emplastrum lithargyri* .. 811
    2. *Calcis plumbis* .. 791
131. Plumbi oxydum rubrum .. 791
132. Plumbi carbonas .. 793
    Unguentum plumbi carbonatis .. 797
133. Plumbi chloridum .. 797
134. Plumbi iodidum .. 799
    Unguentum plumbi iodidi .. 801
135. Plumbi nitras .. 801
136. Plumbi acetates .. 803
  1. Plumbi acetas .. 803
    1. *Ceratum plumbi acetatis* .. 808
    2. *Pilulæ plumbi opiatæ* .. 808

PAGE
2. Plumbi diacetas .. 808
1. *Liquor plumbi diacetatis dilutus* .. 810
2. *Ceratum plumbi compositum* .. 811
3. *Ceratum saponis compositum* .. 810
137. Emplastrum plumbi .. 811
1. *Emplastrum resinæ* .. 812
2. *Emplastrum saponis* .. 812
3. *Unguentum plumbi compositum* .. 812
138. Plumbi saccharas .. 813
139. Plumbi tannas .. 813

ORDER XXVII.—IRON AND ITS COMPOUNDS .. 814

140. Ferrum .. 814
1. *Ferrum in fila tractum* .. 818
2. *Ferri pulvis* .. 818
141. Ferri oxydum nigrum .. 820
142. Ferri sesquioxydum .. 822
Emplastrum ferri .. 824
143. Ferri sesquioxydum hydratum .. 824
144. Ferri carbonas .. 827
1. *Ferri carbonas saccharatum* .. 828
2. *Mistura ferri composita* .. 829
3. *Mistura ferri aromatica* .. 830
4. *Pilulæ ferri compositæ* .. 830
5. *Ferri supercarbonas* .. 830
145. Ferri phosphates .. 831
1. Ferri phosphas .. 831
2. Ferri perphosphas .. 832
3. Ferri subperphosphas .. 832
146. Ferri sulphuretum .. 833
Ferri sulphuretum hydratum .. 834
147. Ferri sulphas .. 835
1. *Ferri sulphas exsiccatum* .. 839
2. *Pilulæ ferri sulphatis* .. 839
148. Ferri persulphas .. 840
149. Ferri sesquichloridum .. 840
Tinctura ferri sesquichloridum .. 841
150. Ferri ammonio-chloridum .. 845
Tinctura ferri ammonio-chloridi .. 846
151. Ferri iodidum .. 847
1. *Ferri iodidum syrupus* .. 850
2. *Pilulæ ferri iodidi* .. 852
152. Ferri ferro-sesquicyanidum .. 852
153. Ferri pernitras .. 855
154. Ferri arsenias .. 856
155. Ferri acetas .. 857
Ferri acetatis tinctura .. 858
156. Ferri lactas .. 859
157. Ferri tannas .. 859
158. Ferri valerianas .. 860
159. Ferri citrates .. 860
1. Ferri protocitras .. 860
2. Ferri percitras .. 860

PAGE
160. Ammoniæ ferrico-citras 860
161. Ammoniæ ferrico-tartras 863
162. Potassæ ferrico-tartras 864
Vinum ferri 867

ORDER XXVIII.—COPPER AND ITS COMPOUNDS 867

163. Cuprum 867
164. Cupri sulphas 871
Cuprum aluminatum 874
165. Ammoniæ cupro-sulphas 875
1. *Pilulæ cupri ammoniati* 877
2. *Cupri ammonio-sulphas* 877
3. *Liquor cupri ammonio-sulphatis* 877
166. Cupri acetates 877
1. Cupri subacetates 877
1. *Cupri subacetas præparatum* 879
2. *Linimentum æruginis* 879
3. *Unguentum cupri subacetatis* 879
2. Cupri acetas 880

ORDER XXIX.—MERCURY AND ITS COMPOUNDS 880

167. Hydrargyrum 880
Hydrargyrum purum 902
168. Hydrargyrum cum cretâ 903
169. Hydrargyrum cum magnesiâ 904
170. Pilulæ hydrargyri 904
171. Unguentum hydrargyri 905
1. *Ceratum hydrargyri compositum* 908
2. *Linimentum hydrargyri* 908
172. Emplastrum hydrargyri 908
Emplastrum ammoniaci cum hydrargyro 909
173. Hydrargyri suboxydum 909
Lotio nigra 910
174. Hydrargyri oxydum rubrum 910
Lotio flava 912
175. Hydrargyri nitrico-oxydum 912
Unguentum hydrargyri nitrico-oxydum 914
176. Hydrargyri sulphuretum 914
1. Hydrargyri sulphuretum crystallisatum 914
2. Hydrargyri sulphuretum amorphum 916
177. Hydrargyri sulphates 917
1. Hydrargyri subsulphas flavus 917
2. Hydrargyri persulphas 918
178. Hydrargyri subchloridum (*calomelas*) 919
1. *Pilula hydrargyri chloridi composita* 928
2. *Pilulæ calomelanos et opii* 928
3. *Unguentum hydrargyri chloridi* 928
4. *Pilulæ catharticæ compositæ* 929
179. Hydrargyri perchloridum (*sublimatus corrosivus*) 929
Liquor hydrargyri bichloridi 937
180. Hydrargyri amido-chloridum 938
Unguentum hydrargyri amido-chloridi 940

PAGE
181. Hydrargyri iodida 940
  1. Hydrargyri subiodidum 940
    Unguentum hydrargyri iodidi 941
  2. Hydrargyri periodidum 942
    1. *Unguentum hydrargyri rubri iodidi* 944
    2. *Liquor arsenici et hydrargyri hydriodatis* 944
182. Hydrargyri percyanidum .. .. · 946
183. Potassii et hydrargyri iodo-cyanidum 949
184. Hydrargyri nitrates 949
  1. Hydrargyri protonitras 949
  2. Hydrargyri dipernitras 950
    1. *Liquor hydrargyri pernitratis* 951
    2. *Unguentum hydrargyri nitratis* 952
    3. *Unguentum hydrargyri nitratis mitius* 954
185. Hydrargyri acetas 954

ORDER XXX.—SILVER AND ITS COMPOUNDS 954

186. Argentum 954
    Argentum purificatum 956
187. Argenti oxydum 957
188. Argenti chloridum 959
189. Argenti cyanidum 960
190. Argenti nitras 961
    1. *Liquor argenti nitratis* 971
    2. *Solutio argenti ammoniati* 972

ORDER XXXI.—GOLD AND ITS COMPOUNDS 972

191. Aurum 972
    Pulvis auri 973
192. Auri teroxydum 974
    1. *Aurum fulminans* 974
    2. *Purpura mineralis cassii* 974
193. Auri terchloridum 974
194. Auri iodidum 975
195. Sodii auro-terchloridum 977
196. Auri tercyanidum 977

ORDER XXXII.—COMPOUNDS OF PLATINUM 977

197. Platini bichloridum 977
198. Sodii platino-bichloridum 978

LIST OF WOODCUTS IN VOL. I.

FIG. PAGE
1. Apparatus for medical electricity . 49
2. Diagram illustrative of the electrical machine 50
3. Diagram illustrative of the voltaic current 54
4. Plan of Cruickshank's battery . . 55
5. The magnetic field 59
6. Festuca quadridentata 86
7. Amanita muscaria 108
8. Apparatus to illustrate physical absorption 111
9. 10. 11. Apparatus used by Messrs. Morgan and Addison in their experiments on the absorption of poisons 115
12. 13. 14. Ditto 116
15. 16. Ditto 117
17. Forms of the cubic system . . . 142
18. Octohedron 142
19. Dodecahedron 142
20. Cube 142
21. Regular tetrahedron 142
22. 23. Images caused by the action of calcareous spar on polarised light 143
24. Forms of the square prismatic system 143
25. Square octohedron 143
26. Square prism 143
27. Combination of octohedron and prism 143
28. Forms of the rhombohedric system 144
29. Rhombohedron 144
30 Hexagonal prism 144
31. Combination of the rhombohedron with the hexagonal prism . . 144
32. Scalenohedron 144
33. 34. Images caused by the action of nitre on polarised light . . . 145
35. Forms of the right prismatic system 145
36. Octohedron with a rectangular base 145
37. Right rectangular prism 145
38. Octohedron with a rhombic base . 145
39. Right rhombic prism 145
40. Forms of the oblique prismatic system 146
41. Oblique octohedron with a rectangular base 146

FIG. PAGE
42. Oblique rectangular prism . . . 146
43. Oblique octohedron with a rhombic base 146
44. Oblique rhombic prism 146
45. Forms of the doubly-oblique system 147
46. Doubly-oblique octohedron . . . 147
47. Doubly-oblique prism 147
48. Manufacture of animal charcoal and bone spirit 323
49. 50. Tyler's improved soda water apparatus 334
51. Boracic acid lagoons 337
52. Chambers for crystallising and drying boracic acid 338
53. Distillation of native sulphur . . 351
54. Distillation of sulphur 352
55. Crystalline form of native sulphur 353
56. Crystalline form of sulphur by fusion 353
57. Sarcoptes hominis 355
58. Microscopic appearance of sublimed sulphur 356
59. Microscopic appearance of pure precipitated sulphur 357
60. Microscopic appearance of commercial precipitated sulphur . . 357
61. Cascade de Vinagre 359
62. Oil of vitriol chamber 361
63. Oil of vitriol manufactory . . . 361
64. Plan of an oil of vitriol manufactory 364
65. Gallery for the distillation of fuming sulphuric acid 364
66. 67. Inhaling bottles 384
68. Apparatus for making hydrochloric acid 390
69. Pure hydrochloric acid apparatus . 391
70. Iodine still and receiver 398
71. Apparatus for detecting nitric acid 426
72. Manufacture of sesquicarbonate of ammonia 452
73. Sublimation of hydrochlorate of ammonia 460
74. Octohedron 75. Cube } of sal ammoniac . 462
76. 77. Crystals of bicarbonate of potash 496
78. 79. 80. Crystals of sulphate of potash . 503

FIG. PAGE
81. Tessellated appearance of a plate of sulphate of potash in polarised light 503
82. Prism of bisulphate of potash . 507
83. Crystal of chlorate of potash . . 511
84. Egg-shaped iron pots and furnaces used for the manufacture of ferrocyanide of potassium . . . 531
85. Truncated octohedron of ferrocyanide of potassium 532
86. Octohedron (primary form) of ferrocyanide of potassium . . . 532
87. Crystal of nitre 540
88. Prism of ditto 540
89. Crystal of tartrate of potash . . 549
90. 91. } Ditto of bitartrate of potash . 551
92. Carbonate of soda furnace . . 559
93. 94. } Crystals of carbonate of soda . 560
95. Prism of sulphate of soda . . . 579
96. Section of a salt mine 582
97. Common salt pan 583
98. Plan of salt marshes 583
99. Cavernous cube of common salt . 586
100. 101. } Crystals of tartarised soda . . 598
102. 103. } Apparatus for the manufacture of chloride of lime 631
104. Chlorometer 636
105. Calcined magnesia furnace . . 643
106. Microscopic appearance of common calcined magnesia . . . 644
107. Microscopic appearance of heavy calcined magnesia 644
108. Manufacture of heavy carbonate of magnesia 649
109. Microscopic appearance of light carbonate of magnesia . . . 651
110. Microscopic appearance of heavy carbonate of magnesia . . 651
111. Microscopic appearance of heavy carbonate of magnesia by polarised light 651
112. Crystals of carbonate of magnesia from Dinneford's solution . . 654
113. 114. } Crystals of sulphate of magnesia 656
115. Crystal of alum 664
116. Section of an arsenic roasting furnace 683
117. Arsenic condensing chamber . . 683
118. Arsenic refining furnace . . . 683
119. Octohedron } of arsenious acid 685
120. Tetrahedron }
121. Sublimed crystals of arsenious acid in glass tube 686
122. Berzelius's arsenic reduction tube 687
123. Apparatus for passing sulphuretted hydrogen through metallic solutions 690
124. Ditto 691
125. 126. 127. 128. } Marsh's apparatus 693
129. Apparatus for subjecting arseniuretted hydrogen to the action of heat or nitrate of silver . . 694
130. Crystal of realgar 722
131. Crystal of orpiment 722
132. Octohedron of emetic tartar . . 743
133. Apparatus for passing sulphuretted hydrogen through a solution of emetic tartar 743
134. Apparatus for reducing tersulphuret of antimony 743
135. Sirocrocis stibica in emetic tartar 744
136. Cube } of bismuth . . . 758
137. Octohedron }
138. Crystal of sulphate of zinc . . 770
139. Wrist-drop } in paralysis from lead . 786
140. Emaciated condition of the flexors of the thumb }
141. Crystal of acetate of lead . . . 804
142. Crystal of sulphate of iron . . 837
143. Prism of sulphate of copper . . 872
144. Henry's apparatus for the sublimation of calomel 921
145. Crystal of calomel 921
146. Corrosive sublimate furnaces . . 930
147. Crystal of corrosive sublimate . 930
148. Apparatus for testing a solution of corrosive sublimate . . . 931
149. Crystal of percyanide of mercury 947
150. Ditto, with modified planes . . 947
151. Crystal of nitrate of silver . . 962

CORRIGENDA.

Page.	Line.	
4	2	from foot, in reference, *for* "Lib. iii. c. 2," *read* "c. 27."
158	19	from foot, *for* "topical," *read* "local."
175	14	from top, *for* "alimencary," *read* "alimentary."
373	7	from foot, *for* "$2SO^2$," *read* "SO^2."
301	17	from foot, *for* "chloride of magnesium," *read* "chloride of sodium," and *vice versâ*.
474	9	from top, *for* "Edinburgh Pharmacopœia," *read* "London and Edinburgh Pharmacopœias."
605	12	from top, *dele* the words "Soap," to "L. D." The line should commence with "Castile Soap, ℥iiss."
605	15	from top, *for* "Spirit of Rosemary," *read* "Proof Spirit."
614	19	from top, after Chloride of Barium, *for* "ʒj." *read* "℥j."
832	12	from foot, *for* "Superphosphas," *read* "Subperphosphas."

ELEMENTS

OF

MATERIA MEDICA.

PROLEGOMENA.

(*Definitions.*)

THERAPEUTICS (*therapeia, therapeutice, therapeutica,* from θεραπεύω, *I cure*) is that branch of medicine which has for its object the treatment of diseases. It is divided into *general* (*therapeia generalis*) and *special* (*therapeia specialis*).

Authors are not agreed as to the proper limits of Therapeutics. In the most extended sense of the word, and which I have adopted in the text, it embraces all the known means of cure, and consequently all surgical operations. Guersent,[1] however, excludes Amputations, Lithotomy, Tracheotomy, &c. from its domains, though he includes Blood-letting, Issues, Setons, Acupuncture, and all those operations which are useful in the treatment of diseases, by producing modifications of the vital properties.

Sprengel[2] applies the term *Iatreusologia* (from ἰατρεύω, *I cure*, and λόγος, *a discourse*) to general therapeutics.

ACOLOGY (*acologia*, from ἄκος, *a remedy*, and λόγος), or *iamatologia*[3] (from ἴαμα, *a remedy*, and λόγος), is that department of therapeutics devoted to the consideration of remedies.

Some authors[4] limit Acology to the consideration of surgical and mechanical remedies.

The term **MATERIA MEDICA** implies material substances employed in the treatment of disease; but, in a more extended sense, it signifies all remedial agents, of whatever kind. It is also used to designate that department of medicine devoted to the consideration of remedies or medicines.

REMEDIES (*remedia*, from *re*, and *medeor*, I heal; *auxilia medica*) are agents used in palliating or curing diseases.

They are of two kinds: those which operate through the agency of the mind; and those which act on the body directly.[5]

---

[1] *Dictionnaire de Médecine*, t. xx. art. *Thérapeutique*, 1828.

[2] *Institutiones Medicæ*, t. i. p. 7.

[3] C. H. E. Bischoff, *Die Lehre von den chemischen Heilmitteln*, Bd. i. S. 22, Bonn, 1825.

[4] Sprengel, and C. H. E. Bischoff, *op. supra cit.*

[5] Strictly speaking, this division is, perhaps, inaccurate; since we know that changes in the condition of the brain produce corresponding alterations in the state of the mind; and it may be fairly inferred, that changes in the state of the mental faculties are necessarily associated with some mo-

The first may be denominated *psychical* or *mental* remedies; the second, *somatical* or *corporal.* The latter are subdivisible into *imponderable, hygienic, mechanical,* or *surgical,* and *pharmacological* agents.

PART I.—PSYCHICAL OR MENTAL REMEDIES.

(*Remedia psychica*).

Affections of the mind, by their influence over the corporal functions,[1] favour or oppose the action of morbific causes, and modify the progress of diseases. The methodical application of them as remedies constitutes the *psychical method of cure.*[2] Regarded as therapeutical agents, they are by no means unimportant, or to be neglected; though their employment is necessarily limited, on account of the difficulty experienced in producing, regulating, and controlling them.

They are of two kinds, *external* and *internal.*[3]

1. EXTERNAL AFFECTIONS OF THE MIND.

(*Sensations*).

Those mental affections which immediately result from the influence of agencies external to the mind, are denominated *sensations* or *external mental affections.* They arise either from influences external to the body (*external sensations*), or from organic causes existing within the body (*internal sensations*).

External sensations are frequently excited for therapeutical purposes. Their influence over disease is either direct or indirect. It is *direct* when the effect is the immediate result of impressions made on the sensitive nerves. In this case sensations usually act either as excitants or as soothing and tranquillizing agents. Thus, strong light and loud noises are excitants; while monotonous impressions on the auditory or optic nerves dispose to sleep. The influence is *indirect* when the effect arises from internal mental affections suggested by the sensations. Thus the remedial influence of music is indirect, because it is referable, not to the mere perception of sounds, but to the resulting emotions. In such cases, the effect being due to associated ideas or suggested feelings, is not uniform.

1. SMELL.—Those substances which are employed in medicine on account of their odour, are denominated Odoraments (*Odoramenta*). They are used for various purposes, of which the following are examples:—

---

lecular alteration in the cerebral substance. If this be true, all remedies are somatical or corporal. But at present it is convenient to speak of *mental* as distinguished from *corporal* agents, just as we speak of *functional* as distinguished from *organic* diseases.

[1] For some pertinent observations on the powerful influence of mental impressions in deranging the functions of the body, see Dr. J. Johnson's *Essay on Indigestion*, 10th edit. 1840.

[2] J. C. Reil, *Rhapsodieen über die Anwendung der psychischen Kurmethode auf Geisteszerrüttungen*, 2d Ausg., Halle, 1818. Also, E. F. von Feuchtersleben, *Lehrbuch der ärztlichen Seelenkunde*, Wien, 1845.

[3] On this subject consult Dr. Thomas Brown's *Lectures on the Philosophy of the Human Mind*, vol. i. p. 341, 2d edit. 1824.

α. Strongly odorous vapours (as of ammonia and acetic acid) are used, both as preventives and remedies, for fainting, and attacks of hysteria and epilepsy.

β. Fragrant substances are employed both for the agreeable sensations they excite, and for the purpose of overpowering or disguising disagreeable odours. The *pot-pourri* or scent-jar, the *sachet* or scent- or sweet-bag, the sweet coffer, perfumed oils, spirits, and waters, scented soaps, fumigating pastils, &c. are used for these purposes. Perfumes are to be distinguished from substances called disinfectants; the former disguise, while the latter destroy, noxious vapours, &c.

Odorous emanations from young and vigorous animals have been esteemed salutary;[1] and to them have been sometimes, though erroneously, ascribed the beneficial effects supposed to arise from a residence in stables[2]; as well as from the ancient practice[3] of putting young, vigorous, and healthy subjects to bed with the old and enfeebled.[4]

In considering the therapeutical influence of odours, the singular sensitiveness of some constitutions (the hysterical chiefly) to perfumes should not be forgotten. The inhabitants of Rome, especially the females, are remarkable for this peculiarity. In them, headache and numerous other nervous affections are readily produced by the agreeable odours of flowers and other perfumes.[5]

2. TASTE.—Sapid substances are frequently employed in medicine for affecting the sense of taste, as in the following instances:—

α. Pungent and acrid substances (as horseradish and ginger) are employed to excite the gustatory nerve in ageustia, or loss of taste.

β. Bitters, and the substances called *condiments*, heighten the appetite for food, for which we frequently use them in medicine. They probably act, in part at least, by their action on the nerve of taste.

γ. An important object in the art of prescribing is to disguise the unpleasant taste and smell of medicines by substances possessing a more agreeable flavour and odour.[6] The employment of gelatinous and membranous capsules to envelope medicines, has for its principal object the avoidance of the unpleasant taste of the substances swallowed.

δ. In some nervous cases, we endeavour to increase the faith of our patients in the powerful agency of the remedies employed, by augmenting the odorous and sapid qualities of the substances used.

3. HEARING.—Impressions made on this sense are useful as remedial agents, either by their direct effects, or indirectly by the internal affections of the mind which they give rise to.

α. Noises act as direct mental stimulants. They check sleep, and are sometimes useful by diverting the attention.[7]

β. Monotonous sounds (as the humming of bees, the ticking of a clock, the murmur of a rivulet, a dull discourse, &c.) soothe and dispose to sleep. In therapeutics we avail ourselves of this fact, and combat want of sleep by directing an attendant to read aloud and monotonously to our patient.

γ. Silence disposes to sleep. In cases of vascular or nervous excitement of the brain, in fevers, and in many other cases where sleep is desired, silence should be enjoined. Under some circumstances, however, silence "may become a stimulus when sound ceases to be so. Thus, a miller being very ill, his mill was stopped, that he might not be disturbed with its noise; but this, so far from inducing sleep, prevented it altogether; and it did not take place till the mill was set a-going again."[1]

---

[1] H. Cloquet, *Osphrésiologie; ou Traité des Odeurs, du Sens et des Organes de l'Olfaction*, Paris, 1821.

[2] Beddoes, *Observations on the Medical and Domestic Management of the Consumptive*, &c., Lond. 1801.

[3] 1 *Kings*, chap. i. v. 1—4.

[4] *Anecdota Sydenhamiana*, p. 62, Lond. 1845. Copland, *Dict. of Pract. Medicine*, vol. i. p. 475, and vol. iii. p. 135.

[5] Sir James Clark, *The Sanative Influence of Climate*, p. 230, 3d edit., Lond. 1841. Orfila, in his *Traité de Toxicologie*, vol. ii. p. 543, Paris, 1843, has collected several cases of supposed poisoning by the emanations of odoriferous plants. In the case of Caspar Hauser (see Copland's *Dict.* vol. i. p. 474), the most remarkable and singular effects were produced by odours.

[6] For illustrative examples, see Paris's *Pharmacologia*, p. 443, 9th edit. 1843.

[7] "Quorundam discutiendæ tristes cogitationes; ad quod symphoniæ, et cymbala, strepitusque proficiunt" (Celsus, lib. iii. c. 18).

δ. Harmonious and melodious sounds influence the mind chiefly in an indirect manner, and excite a sensation of either pleasure or pain, according to the nature of the ideas they are associated with, or the feelings which they suggest (see *Music*).

4. Vision.—On this sense, as on hearing, remedial impressions act either directly or indirectly.

α. Strong light operates as a mental excitant, and checks sleep. In bright solar light we feel more active, cheerful, and happy; whereas obscurity and darkness give rise to a gloomy and depressed condition of mind: hence, insolation in the open air is employed as a mental stimulus in melancholy, lowness of spirits, and despondency.

β. Different coloured lights exercise different effects on the mind. Thus, certain tints are popularly called cheerful or lively, while others are termed sombre. Hence, in the treatment of insanity, the colour both of the patient's chamber, and of the works of art which surround it, is not undeserving of attention. Feuchtersleben suggests the use, in these cases, of coloured glass for windows and spectacles.

γ. Sleep is promoted by "the sight of any thing waving; as of a field of standing corn, or of the hand drawn up and down before the face by a mesmeriser, attracting attention much more than an object at rest."[2]

δ. Darkness, especially when accompanied with silence, has a calming and depressing influence, and disposes to sleep. Hence it is employed in cases of great vascular or mental excitement of the brain, and where we desire to produce sleep. In some instances it excites great terror.

ε. Fixing the eyes steadily on a single object, as a candle, or a hole in the wall, will sometimes induce sleep.

5. Touch.—Of the therapeutical uses made of this sense, the following are a few illustrations:—

α. Gentle friction[3] with the fingers on some part of the body disposes to sleep. Its soothing and lulling effects I have repeatedly experienced when suffering from severe headache. "I know a lady," says Dr. Elliotson,[4] "who often remains awake, in spite of every thing, till her husband very gently rubs her foot."

β. "A combination is still more effective: whence, experience has taught nurses to rock, and otherwise agitate infants, while they hum them to sleep."[5]

γ. Freedom from pain and from uneasiness of any kind favours sleep.

δ. In some soporose affections, as poisoning by opium, apoplexy, &c. remedies are resorted to which, by exciting the sensibility of the body, are calculated to rouse the patient, and prevent sleep. Various methods of causing pain have been devised: one of the oldest is *urtication*, or flagellation by a bunch of nettles (*Urtica dioica*). This practice is mentioned by Celsus.[6]

ε. Pectination, or combing the hair, disposes to sleep, and is often resorted to for this purpose.

ζ. Brushing is used to allay cutaneous irritation, and occasionally to provoke sleep.

η. Rubbing, and various other kinds of manipulation, are employed as soothing means. Dry rubbing is very serviceable in œdema of the limbs.

θ. Titillation has been suggested and used by Mr. Wardrop[7] as a remedy for paralysis (of sensation?). The mode adopted was to pass a feather lightly across the palm of the hand, three or four times daily, until laughter was occasioned.

---

[1] Dr. Robert Macnish's *Philosophy of Sleep*, p. 32, Glasg. 1830.

[2] Dr. Elliotson's *Human Physiology*, p. 608, 5th edit. 1840.

[3] The friction above referred to should be very light and gentle. Strong or violent friction by the hand or horse-hair gloves is used for other purposes; as, for allaying itching and irritation of skin, and promoting cutaneous circulation. Dinneford's "*Patent improved Electrical Horse-hair Renovators*" are, for these purposes, a great improvement over the ordinary horse-hair gloves.—On the subject of friction as a remedial agent, the student may consult Celsus, lib. ii. c. 14.

[4] *Op. cit.* p. 609.

[5] *Ibid.*

[6] Lib. iii. c. 2.

[7] *Edinb. Med. and Surg. Journ.* vol. viii. p. 197.

Monotony.—It has been already stated that monotonous impressions on the organs of hearing, seeing, or feeling, are great provocatives of sleep. This is the principle of the "method of procuring sound and refreshing slumber at will" recommended by the late Mr. Gardner, who called himself the *hypnologist.* His method was for some time kept secret, and was first made public by Dr. Binns.[1] It is as follows:—

> Let the patient "turn on his right side, place his head comfortably on the pillow, so that it exactly occupies the angle a line drawn from the head to the shoulder would form, and then, slightly closing the lips, take rather a full inspiration, breathing as much as he possibly can through the nostrils. This, however, is not absolutely necessary, as some persons breathe always through their mouths during sleep, and rest as sound as those who do not. Having taken a full inspiration, the lungs are then to be left to their own action; that is, the respiration is neither to be accelerated nor retarded too much; but a very full inspiration must be taken. The attention must now be fixed upon the action in which the patient is engaged. He must depict to himself that he sees the breath passing from his nostrils in a continuous stream, and the very instant he brings his mind to conceive this apart from all other ideas," he sleeps. "The instant the mind is brought to the contemplation of a single sensation, that instant the sensorium abdicates the throne, and the hypnotic faculty steeps it in oblivion."

2. INTERNAL AFFECTIONS OF THE MIND.

This division of mental affections includes the *feelings* and the *intellect.*

1. THE FEELINGS.

Under the denomination of *feelings* or *affective faculties* are included what the phrenologists denominate the *propensities* and *sentiments.*

The therapeutical regulation of the feelings or passions is principally resorted to in nervous and mental disorders, and consists in the repression or encouragement of particular feelings according to the circumstances of each case. "One insane," observes Dr. Spurzheim,[2] "will behave well by veneration; another by fear; a third will be guided by love of approbation, often by attention paid to his self-esteem; many, by gentle manners and kindness; melancholic, anxious, and fearful patients, by the greatest mildness." The same author further observes: "Every object which may excite the deranged feelings must be removed. This is the case with religious insanity, in pride, in melancholy, and in any other feeling. How injudicious is it, therefore, to give books to persons insane from religion, or to let them hear sermons, which nourish their disorders; or to keep with melancholics a conversation on the subject of their despondency!"

Hope is a mildly stimulating or tonic passion, which may be beneficially employed in most cases, and which proves injurious in few, if any. Most patients receive, with satisfaction and benefit, assurances from their medical attendant of the prospect of recovery. Even in diseases of a mortal character, life may be sometimes prolonged by concealing from the sufferer the fatal nature of his malady.[3]

---

[1] *The Anatomy of Sleep; or, the Art of procuring sound and refreshing Slumber at Will*, p. 436, 2d edit. 1845.

[2] *Observations on the Deranged Manifestations of the Mind, or Insanity*, Lond. 1817.

[3] For some judicious remarks, by Sir H. Halford, on the duty of the physician, in withholding from, or communicating to a patient, the probable issue of a disease displaying mortal symptoms, see *London Medical Gazette*, vol. vii. p. 602. I fully agree with the late learned President of the College of Physicians, that the first duty of the physician is, "to protract the life of his patient by all practicable means."

Faith in the beneficial agency of the remedies employed, and *confidence* in the skill of the medical attendant, are important adjuvants in the treatment of most diseases. To them both physician and empiric owe part of their success; and it is, therefore, the duty of the practitioner to encourage these feelings in his patient by every legitimate and honourable means.

The influence of the *imagination* on disease has long been known, and is a fruitful source of fallacy in therapeutics. Extraordinary cures have frequently been ascribed to inert and useless means, when, in fact, they were referable to the influence of the imagination.[1]

Fear is a depressing and debilitating passion, of whose power over disease the practitioner has sometimes availed himself. Thus Boerhaave prevented the recurrence of epileptic attacks (brought on by a person falling down in a fit in the sight of the hospital patients), by directing a red-hot iron to be applied to the person who should next be affected.[2]

Removal from home, or separation of the insane from their families and society, is an important agent in the treatment of lunatics, and the influence of which is referable chiefly to the feelings and passions. It is calculated to act beneficially, by withdrawing the patient from the influence of domestic circumstances calculated to add to, or at least to keep up, the morbid condition, and by presenting new objects to his view, which arrest his attention, and excite new trains of ideas.[3] "Persons insane by pride," observes Dr. Spurzheim, "are seldom cured in the bosom of their family, where they are accustomed to command." In this case removal is desirable; so also, in madness from misanthropy, jealousy, hatred, or malice, removal is absolutely necessary. There are cases, however, where separation is objectionable; as where the intellect is not much disordered, and the attachment of the patient to his relatives is very strong.

There can be no doubt that the injurious effects of *coercion* or *restraint*, formerly considered essential to the successful treatment of insanity, are chiefly referable to the injured feelings.[4]

The state of the *sexual feelings* frequently demands the attention of the physician. Marriage is sometimes recommended to remove the temptation to solitary vice; and, in epileptic and hypochondriacal cases, I have witnessed its beneficial effects. There are cases, however, where it may prove injurious, as in diseases of the heart.

2. THE INTELLECT.

Under this head are included both the *perceptive* and *reflective faculties*, which, as well as the feelings, may be frequently and advantageously influenced for therapeutical purposes.

The influence of *music* is referable to this head. It has been employed in the treatment of diseases (especially those of the mind) from very remote times.[5] The most ancient notice of its remedial use occurs in the Bible,[6] where the sacred historian tells us that David cured the melancholy of Saul by it. This happened more than a thousand years before Christ. The ancient Greeks also had recourse to music in medicine, though Hippocrates makes no mention of it. It would appear to be principally adapted for the relief of the melancholic form of insanity, but its beneficial effects are very transitory, and have been greatly exaggerated. Esquirol[7] tried it at Charenton in every way, and under the most favourable circumstances, but with little success. "Sometimes," he reports, "it rendered the patients furious, often it appeared to divert them; but I cannot affirm that it contributed to their recovery. To the convalescent, however, it proved advantageous." A more recent writer (Dr. Conolly) also observes,[1] that "little regard is probably due to music as a remedial means, its effects being usually only temporary. Violent patients often become silent, and are then moved to weeping, when the piano is played to them." As, in the therapeutical employment of music in insanity, our object is to create agreeable emotions, by recalling the happy events of by-gone times, and by restoring old associations and trains of thought, particular attention should be paid to adapt the character of the music to the peculiarities of each case; for it is obvious that what may prove beneficial to one patient may be injurious to another.

---

[1] See Dr. Haygarth's *Of the Imagination as a Cause and a Cure of Disorders of the Body, exemplified by fictitious Tractors and epidemical Convulsions*, in the *London Medical Review*, vol. iii. p. 28, 1800; also, Dr. Lind's *Treatise on the Scurvy*, p. 343 et seq. and p. 535, 3d ed. 1772.

[2] See Dr. Wm. Falconer's *Dissertation on the Influence of the Passions upon Disorders of the Body*, p. 100, 2d ed. Lond. 1791.

[3] On this subject consult Esquirol, *Des Malades Mentales*, t. ii. p. 743, Paris, 1838. Also, Prichard's *Treatise on Insanity;* and Dr. Conolly *On the Advantages and Disadvantages of Removal of the Patient from Home*, in the *Lancet* for April 25th, 1846.

[4] For an account of the *non-restraint* system pursued at Hanwell, see Dr. Conolly's Lectures in the *Lancet* of Nov. 1, 1845. In cases of great violence, seclusion in a padded room is substituted for bodily coercion.

[5] F. A. Steinbeck, *Diss. Inaug. de Musices atque Poësos*, Berol. 1826.

[6] 1 *Samuel*, xvi. 15—23.

[7] *Des Maladies Mentales*, t. ii. p. 538, Paris, 1838.

Reasoning, with nervous, hypochondriacal, and insane patients, rarely proves serviceable. This arises chiefly, perhaps, from the circumstance that the malady in these cases is more frequently seated in the feelings than in the understanding; and wherever strong feelings are deranged, little effect is to be expected from reasoning. In many instances it is absolutely injurious, "by exciting irritation in the mind of the sufferer, who thinks his counsellors are either unfeeling or incredulous towards his complaints."[2]

PART II.—PHYSICAL BUT IMPONDERABLE REMEDIES.

(*Remedia physica.*)

In this Part we have to consider Light, Heat, Electricity, and Magnetism, as remedial agents.

1. LUX.—LIGHT.

(*Lumen.*)

Properties of Solar Light.—Solar light possesses several distinct properties or qualities: it illuminates bodies; it raises their temperature; it effects in them various chemical changes; and on some it confers the faculty of being self-luminous or phosphorescent.

To account for these properties, the *corpuscular hypothesis* assumes the existence of as many kinds of imponderable matter as there are classes of properties. Thus the illuminating quality is ascribed to an imponderable termed light, the calorific property to caloric, the chemical property to tithonicity,[3] and the phosphorogenic property to an imponderable which has not hitherto received a name.[4] But the *undulatory hypothesis* explains the phenomena by assuming the existence of one imponderable or ethereal medium, to the mechanical action of whose vibrations or undulations on the atoms of matter all these properties of solar light are ascribed; the differences in the effects of this action depending on differences in the frequency of the undulations. Of the undulations which excite the sensation of colour, the shortest and most frequent are assumed to produce the sensation of violet; while the longest and least frequent give rise to the sensation of red. The greatest chemical effects are supposed to result from undulations which are more frequent, but shorter, than those which give rise to the greatest calorific effects. Lastly, the phosphorescence is supposed to arise from the neutralisation of the two electricites which are separated from each other by the mechanical action of the undulations on the atoms of the phosphorescent body.[1]

---

[1] *The Report of the Resident Physician of the Hanwell Lunatic Asylum, presented to the Court of Quarter Sessions for Middlesex, at the Middlesex Sessions*, 1840.

[2] *Change of Air, or the Pursuit of Health and Recreation, illustrating the beneficial influence of bodily exercise, change of scene, pure air, and temporary relaxation, in sickness and in health*, by James Johnson, M.D. 4th ed. 1838.

[3] *Tithonicity*, from Tithonus, a beautiful youth with whom Aurora fell in love! (Draper, *Lond. Edinb. and Dubl. Phil. Mag.* vol. xxi. 1842).

[4] Draper, *op. cit.* vol. xxv. 1844.

PHYSIOLOGICAL EFFECTS.—In the organised world, light performs important functions, and acts as a vivifying or vital stimulus.[2] This physiological property may be a primary or secondary quality of light; that is, it may be an influence distinct in its nature from any of the physical properties already alluded to, or it may be a consequence of them.

Morning light is popularly believed to exercise a more beneficial influence on the nutrition of animals and plants, than afternoon light. If this notion be well founded, it lends support to the opinion that the physiological effects of light are connected with the chemical influence of this agent; for, in photographical experiments, it is usually found that the rays of the morning sun are more effective than those of the afternoon sun.

Light promotes the nutritive processes of vegetables, and is the cause of the green colour of plants. That curious phenomenon denominated the *sleep of plants* is supposed to be connected with the absence of light. A morbid condition, called *etiolation,* or *blanching,* is observed in vegetables which grow in obscure places.[3]

On animals light operates in a two-fold manner: it promotes their development and nutrition, and it acts as a specific stimulus to the eye, as the organ of vision.[4]

Privation of light disposes to inactivity and sleep. Edwards found that it retarded or prevented the hatching of the ova of frogs. The disease called *Anæmia* or *Hypæmia* in man, is analogous to the condition termed etiolation in vegetables; and, like the latter, is sometimes referable to deprivation of light,—combined, however, with other deleterious causes.[5]

Amaurosis (retinitis?) occasionally results from the exposure of the eye to strong light. The effect of the sun-stroke (*coup de soleil,* or *ictus solaris*), in inducing inflammation of the brain, may be in part, perhaps, owing to the influence of the light of the solar rays.

USES.—In maladies characterised by imperfect nutrition and sanguification, —as scrofula, rickets, and anæmia,—and in weakly subjects with œdematous limbs, &c., free exposure to solar light is sometimes attended with very happy effects. Open and elevated situations probably owe part of their healthy qualities to their position with regard to it. The observations of Dr. Edwards on the influence of light in promoting the perfect development of animals, led him to conclude that, in climates where nudity is not incompatible with health, exposure of the whole surface of the body to light is favourable to the regular conformation of the body; and he has therefore suggested insolation in the open air as a means calculated to restore healthy conformation in scrofulous children whose deviations of form are not incurable.[1]

---

[1] E. Becquerel *On the Constitution of the Solar Spectrum.* In Taylor's *Scientific Memoirs,* vol. iii. 1843.

[2] The phrase *vivifying* or *vital stimuli* is used to designate those external conditions necessary to the maintenance of life in organised beings; such as heat, air, water, and nutriment. They are to be distinguished from the *alterative* or *medicinal stimuli,* which, while they cause temporary excitement, ultimately exhaust (see Müller's *Elements of Physiology,* by Baly, vol. i. pp. 28 and 57).

[3] For details respecting the influence of light on vegetation, consult J. C. Ebermaier, *Versuch einer Geschichte des Lichtes,* Osnabrück, 1799; Landgrebe, *Ueber das Licht, vorzugsweise über die chemischen und physiologischen Wirkungen desselben,* p. 187, Marburg, 1834; R. Hunt, *Researches on Light,* Lond. 1844; Gardner (of America), *Lond. Edinb. and Dubl. Phil. Mag.* vol. xxiv. 1844. Also, De Candolle, *Physiologie végétale,* t. iii. p. 1069, Paris, 1832.—Stark, in his *Allgem. Pathol.* p. 211, Leipzig, 1838, gives a complete account of the literature of this subject.

[4] On the influence of light on animals, see J. C. Ebermaier, *op. supra cit.;* E. Horn, *Ueber die Wirkungen des Lichts auf den lebenden menschlichen Körper,* Königsberg, 1799; Landgrebe, *op. supra cit.* p. 370; and W. F. Edwards, *De l'Influence des Agens physiques sur la Vie,* p. 394, Paris, 1824.

[5] See the case of the workmen employed in a French coal-mine, detailed in the *Dictionnaire de Médecine,* art. *Anémie;* and M. Andral's *Treatise on Pathological Anatomy,* translated by Drs. Townsend and West, vol. i. p. 97.

1. *Darkness.*

In all diseases of the eye attended with local vascular or nervous excitement, in inflammatory conditions of the brain, in fever, and in mental irritation, whether attended or not with vascular excitement, the stimulus of light proves injurious, and in such cases darkness of the chamber should be enjoined. After parturition, severe wounds, and surgical operations, and in all inflammatory conditions, exclusion of strong light contributes to the well-doing of the patient. Lastly, darkness is employed to promote sleep.[2] In most cases where obscurity is indicated, rest and quietude should be enjoined.

2. *Dioptric Instruments.*

When vision is imperfect from defect of focal distance, *i. e.* from some defect of the image-forming parts of the eye, the remedy consists in the use of dioptric or refracting instruments (*eye-glasses; spectacles*). In *myopia* (i. e. *short-* or *near-sightedness*), double concave lenses are usually employed, to counteract the over-refractive power of the humors; while, in *presbyopia* (*long-* or *far-sightedness*), convex lenses or magnifiers are generally used, to obviate the diminished refractive power of the humors of the eye.[3] These are generally double convex glasses; but, for couched eyes, plano-convex glasses are frequently employed, in order to give a larger field of vision.

Lenses for the above purposes are commonly made either of flint-glass or of Brazilian quartz.[4] The latter, called *pebble*, has the advantage of greater hardness, and it is not, therefore, so readily broken or scratched.[5] The diathermancy of quartz is about the same as that of mirror-glass.[6]

---

[1] *Op. supra cit.* p. 401.

[2] See p. 4.

[3] In opticians' shops two *trial boxes*, or *frames of sight*, are kept; the one comprises the range of double convex, the other of the double concave lenses. These are used for trying myopic or presbyopic eyes.

[4] Quartz presents some remarkable optical phenomena. It possesses the property of double refraction in the direction of its axis. In this it differs from every other known uniaxial crystal. Moreover, when a plane-polarised ray is transmitted through a prism of quartz, the two pencils, into which the ray is divided, are, at their emergence, elliptically polarised (Airy, in *The Transactions of the Cambridge Philosophical Society*, vol. iv. 1833).

[5] Lenses made of amber are readily scratched, and soon lose their polish.

[6] Melloni, *Taylor's Scientific Memoirs*, vol. i. p. 1. The transcalency or diathermancy of several transparent solids is as follows:—

Of 100 rays of heat proceeding from the flame of an Argand lamp, there were transmitted by

	Rays transmitted.		*Rays transmitted.*
Rock salt	92	Mirror glass	62
Iceland spar	62	Alum	12
Quartz	62	Sulphate of copper (diaphanous)	0

In another series of experiments Melloni ascertained the relative diathermancy of flint-glass, mirror (plate) glass, and crown-glass, to be respectively 65, 62, and 49.

Occasionally lenses of other forms than those above enumerated are employed; but the only one deserving of special notice is the *periscopic* or *meniscus* (concavo-convex) lens, recommended by Dr. Wollaston,[1] for enlarging the field of vision.[2]

Double Convex Lenses, for Long-sightedness.			Convex Lenses, for Couched Eyes; or Cataract Glasses.		Double Concave Lenses, for Short-sightedness.		
Sights.	*Inches Focus.*		*Inches Focus.*		*Nos.*	*Inches Focus.*[3]	
000	60	Rarely used.	2	For reading.	000	36	Rarely used.
00	48		2¼		00	30	
0	40		2½		0	24	
First	36		2¾		1	20	
Second	30		3		2	16	
Third	24				3	14	
Fourth	20		3½	For distant objects.	4	12	
Fifth	16		3¾		5	10	
Sixth	14		4		6	9	
Seventh	12		4¼		7	8	
Eighth	10		4		8	7½	
Ninth	9		4¾		9	7	
Tenth	8				10	6	
Eleventh	7				11	4¾	
Twelfth	6				12	4¼	
Thirteenth	5				to		
					20		

3. *Chromatic Instruments.*

In some affections of the eye (popularly known as *weakness of sight*), coloured glasses are employed, with occasional relief, to diminish the intensity of light. Those with a neutral or grey tint (or twilight tinge), recommended by Mr. Mayo,[4] prove the most agreeable to the eye.

White light is most fatiguing and hurtful to the eye.[5] The disease called snow-blindness, which sometimes results from the long contemplation of a country covered with snow, is probably retinitis.[6]

Both *red* and *yellow*[7] light are injurious to the eye. To the excess of the yellow and red rays in common artificial light, may be in part ascribed the baneful influence of this light in causing impaired vision. Two modes of preventing its ill effects have been suggested; viz. the addition, by reflection, of the blue rays that are deficient (as by the use of conical blue shades or reflectors around the flame); or the subtraction, by absorption, of the red or yellow rays that are in excess (as by passing the light through blue glass, or some other transparent medium of a blue tint).[8]

---

[1] *Nicholson's Journal*, vols. vii. and viii.

[2] For further information respecting spectacles, consult Mackenzie's *Practical Treatise on Diseases of the Eye*, pp. 784 and 792, 3d edit. Lond. 1840; Kitchener's *Economy of the Eyes*, Part 1—Spectacles, 2d edit. Lond. 1826; and Cox's *Spectacle Secrets*, Lond. 1838.

[3] A concave glass of a given number of inches focus is considered to be equivalent to a convex glass of the same number of inches focus; because, when superposed, the refraction of the one exactly neutralises that of the other.

[4] *The Philosophy of Living*, Lond. 1838.

[5] The intense light caused by the ignition of charcoal and the combustion of metals effected by the voltaic battery constructed by Mr. Grove, has produced on myself, as well as on some friends, temporary blindness. The symptoms (which lasted two days in my case) were those of retinitis, with profuse lachrymation.

[6] Mackenzie, *op. supra cit.* p. 501.—Xenophon (*Anabasis*, lib. iv.) speaks of snow-blindness.

[7] Hence, amber lenses, as well as amber-coloured glass lenses, are objectionable.

[8] See Dr. James Hunter's work, *On the Influence of Artificial Light in causing impaired Vision*, Edinburgh, 1840.

Green, blue, indigo, and *violet* lights are much less injurious than either red or yellow. Spectacles of these colours have been made for the use of those suffering with sensitive eyes; but they are inferior to the neutral tint before mentioned, since, after their removal from the eyes, every object sometimes presents for a short period complementary tints; shewing that these colours have fatigued the retinæ.

All dark-coloured glasses, however, and especially black crape spectacles, are objectionable, on account of their greater power of absorbing and radiating caloric, by which they prove heating to the eyes.[1]

2. CALOR.—HEAT.

PHYSIOLOGICAL EFFECTS.—All living beings, but especially the animals denominated *warm-blooded,* generate heat. To all a certain temperature (which differs in different individuals) is essential to the maintenance of life; and hence caloric or heat is a vital stimulus.[2] Increased beyond a certain degree, it ceases to be vivifying: it may cause inflammation or apoplexy; it may exhaust by its prolonged stimulant operation; or, when its action is very violent, it may decompose the organised tissues by its chemical influence.

The effects of caloric on living beings are threefold, viz.:—

1. PHYSICAL; including *expansion* or *dilatation, fluidity,* and *augmented temperature.*
2. CHEMICAL; comprising *increased tendency to changes of composition* and *decomposition.*
3. DYNAMICAL, PHYSIOLOGICAL, or VITAL; comprehending all *changes in the condition of the vital properties* produced by heat. These changes are of two kinds,
    - α. *Primary;* exaltation, excitement, or augmentation, of vital action.
    - β. *Secondary;* exhaustion, or diminution, of vital action.

a. On Vegetables.—A certain degree of heat promotes all the vital processes of plants. It accelerates germination, the growth and development of all vegetable organs, inflorescence, fecundation, and the ripening of the fruit; and it quickens the movements of parts susceptible of motion. Too elevated a temperature, accompanied with dryness, deranges the health of plants;[3] and an intense heat decomposes the vegetable tissues.

b. On Man and other Animals.[4]—A certain degree of external heat (different in different beings) promotes the vital manifestations of animals, and hence we denominate it an excitant or stimulant. Its prolonged operation, however, is followed by debility and exhaustion proportionate to the previous excitement.

α. Effects of heat applied topically.—The effects of topical heat are, first, a sensation of warmth, redness, turgescence, and a slight augmentation of temperature of the part heated. The diameters of the minute capillary vessels expand under the influence of caloric, and thus the red blood-disks are enabled to enter tubes which were previously impervious to them. The augmented volume of the part arises, therefore, in a great measure from the presence of an increased quantity of blood; but in part also from the physical

---

[1] Melloni (*op. supra cit.*) ascertained the diathermanous properties of coloured glasses to be as follows:

Of 100 incident rays, there are transmitted by

Coloured glass.	*Rays transmitted.*	*Coloured glass.*	*Rays transmitted.*
Deep violet	53	Bright yellow	34
Vivid red	47	Mineral green	23
Clear blue	42	Very deep blue	19

[2] See foot-note at p. 8.

[3] De Candolle, *Physiologie Végétale,* t. iii. p. 1098.

[4] See Stark's *Allgem. Pathol.* S. 226 and 1170, Leipzig, 1839, for the literature of this subject.

dilatation of the solids and fluids caused by their augmented temperature. The living tissues become more relaxed, soft, and flexible, under the influence of a moderate heat, and admit of a more rapid transpiration.

A more violent degree of heat causes burning pain, redness, and vesication. A still more intense heat destroys vitality and organisation. Whenever a large portion of the surface of the body is destroyed (as in burns and scalds), great constitutional disturbance, or even death, results from the shock given to the nervous system. Acute ulceration of the duodenum is not an infrequent cause of death in cases of severe burns.[1]

β. *Effects of heat applied to the whole body.*—If the whole body be subjected to an elevated temperature, not incompatible with prolonged life, its effects are manifested first in the vascular system, and in the organs connected therewith. The superficial vessels enlarge; the skin becomes redder; and the pulse quicker and fuller: respiration is more frequent; the animal heat is augmented; and the expired air is hotter, and more loaded with vapour.

Increased exhalation (first of insensible and vaporous matter, then of visible and liquid sweat) and augmented secretion of the periphery soon succeed. The rapid conversion of a liquid into an aeriform fluid (insensible perspiration) is attended with the production of cold; and thus animals are enabled to counteract external heat, and to maintain nearly their original temperature, when exposed to a temperature considerably higher than that of their own bodies, by the increased perspiration which they suffer under these circumstances. The determination of the surface, and the increased transpiration and secretion of the skin, are attended with a contemporaneous diminution of activity in some of the internal organs. Thus, the secretions of the kidneys and of the mucous membranes are diminished in consequence of the increased secretion and exhalation of the skin.

The mutually-antagonizing influence of determinations of blood to different parts—as well as of the secretions of different tissues—is a circumstance the knowledge of which is of great practical value in therapeutics.[2]

The augmented secretion of bile, and the tendency to hepatic diseases, so commonly observed in Europeans when they become residents in warm climates, are other effects of the continued operation of heat on the body.[3]

That heat, aided by inactivity and excess of food, is capable of inducing hepatic disease, is well shown in the case of the goose. The celebrated *pâtés de foies gras*, prepared at Strasburg and Metz, are made from the artificially enlarged livers of geese. The birds are shut up in coops, within heated rooms, and are frequently crammed with food.

Relaxation of the living tissues is another consequence of the employment of moderate heat. This effect, which is best observed when moisture is conjoined with caloric, commences first in the part to which heat is applied: and, when the whole surface of the body has been subjected to an increased temperature, its relaxing influence soon extends to internal parts: hence arise atony, diminution of muscular power, a feeling of languor or fatigue, and an indisposition to corporal exertion.

---

[1] See Mr. Curling's cases in the *Med. Chir. Trans.* vol. xxv. p. 260.

[2] See some valuable remarks on the "*antagonism*" of the secretions, in Müller's *Elements of Physiology*, by Dr. Baly, vol. i. p. 473.

[3] Liebig (*Animal Chemistry*, pp. 23 and 24, Lond. 1842) regards hepatic diseases as diseases "arising from excess of carbon."

The primary effect of moderate heat on the nervous system is excitation; the secondary effect, exhaustion. In the first instance sensibility is agreeably promoted, the action of the voluntary muscles assisted, and the intellect somewhat exalted. But to these effects succeed languor, relaxation, listlessness, indisposition to corporal and mental labour, and tendency to sleep.

The languor, indolence, and relaxed fibres, so commonly observed in the inhabitants of tropical climates, are probably to be ascribed in a great measure to the exhausting and enervating influence of external heat.

Lastly, the prevailing maladies of hot climates may be referred to as farther illustrations of the effect of continued heat on the body. Fevers, diarrhœa, dysentery, cholera, and liver diseases, may be regarded as the special maladies of the burning equatorial regions.

The exhaustion which follows the excitation caused by heat and other stimuli, would seem, to use the words of Müller,[3] to "show that the organic force is consumed, as it were, by the exercise of the functions;" and, to employ a simile of Dr. Priestley,[2] we may say, that as a candle burns out much faster in oxygen gas than in air, so we may be said to live out too fast when under the exciting influence of an elevated temperature.

USES.—As a remedial agent, heat serves several important purposes. It is employed—

1st. To produce local or general excitation of the nervous and vascular systems.

a. To restore the circulation and temperature to their natural standard. *Examples.*—Bottles of hot water to the feet in coldness of the extremities; warm or hot baths in asphyxia from drowning, in collapse from cholera, fevers, &c.; warm baths, or exposure to the rays of a common fire, in old paralytic cases with feeble circulation and cold extremities.

b. To equalise the distribution of blood, and thereby to check a preternatural afflux to other organs. *Examples.*—Warm applications to the feet to relieve determinations of blood to the brain; warm baths in some internal diseases attended with coldness of surface, or which appear to be connected with the disappearance of a cutaneous eruption; warm baths and fomentations in gastritis, enteritis, cystitis, and nephritis.

2ndly. To re-establish or augment secretion and exhalation.

a. To promote diaphoresis. *Examples.*—Warmth to the skin to promote the operation of sudorific medicines; warm baths and warm clothing in diabetes relieve the dry and unperspirable state of skin, and check the excessive secretion of urine; they are also important remedial agents in granular disease of the kidney; warm vapour and water baths in colds, rheumatic affections, scaly diseases, &c.

b. To promote menstruation. *Example.*—Warm baths in amenorrhœa.

c. To promote exhalation and secretion from the air-passages. *Example.*—Inhalation of warm aqueous vapour in irritable conditions of the air-passages.

3rdly. To relax tense, rigid, or spasmodically-contracted tissues.

a. To reduce the contractile power and tension of muscular and other tissues, and thereby to favour the reduction of dislocations and herniæ. *Example.*—Warm baths previous to the attempted reduction of old dislocations and of strangulated herniæ.

b. To soften tissues which are preternaturally rigid. *Example.*—The warm bath, with shampooing, in rheumatic stiffness and rigidity.

c. To relax spasm. *Examples.*—Warm baths and fomentations in tetanus, colic, passage of urinary or biliary calculi, spasmodic retention of urine, &c.

4thly. To soothe and alleviate pain, whether inflammatory, spasmodic, or neuralgic.

---

[1] *Op. cit.* vol. i. p. 52.

[2] *Experiments and Observations on different kinds of Air*, vol. ii. p. 169, Birmingham, 1790.

a. To alleviate inflammatory pain. *Examples.*—Warm water and poultices to burns and scalds, to inflamed and suppurating parts, ulcers, inflamed piles, &c. They relax tissues, and thereby relieve pain from tension.

b. To allay spasmodic pain. *Examples.*—Warm baths and fomentations in strangury, colic, passage of calculi, &c.

c. To allay neuralgic pain. *Examples.*—Fomentations in toothache, faceache, earache, &c.: warm baths in neuralgic dysmenorrhœa, &c.

5thly. To promote the termination of inflammation and its consequences by facilitating certain organic changes.

a. To promote the resolution of inflammation. *Example.*—Warm fomentations and poultices to inflamed parts.

b. To promote suppuration. *Example.*—Warm fomentations and poultices to boils.

c. To further the escape of pus from abscesses. *Example.*—Poultices to abscesses after they have been opened.

d. To promote the separation of sloughs. *Example.*—In some forms of gangrene poultices are useful by promoting the throwing off of the slough.

6thly. To burn or destroy chemically.

a. To destroy poisonous substances introduced into the living tissues. *Example.*—The actual cautery in bites by rabid animals.

b. To destroy morbid growths. *Example.*—The actual cautery to destroy fungus of the antrum.

c. To stop hemorrhage. *Example.*—A hot iron applied to the mouth of the wounded vessel or vessels.

d. To produce revulsion or counter-irritation. *Examples.*—Steam, boiling water, heated metals, moxa, &c. applied to the skin to relieve diseases of internal parts.

e. To open abscesses, close fistulous sores, &c. *Example.*—The actual cautery is occasionally applied in these cases.

CONTRAINDICATIONS.—The most important circumstances which contra-indicate the employment of heat are—

1. Great vascular excitement, plethora, aneurism, dilated heart, hemorrhage, &c.
2. Great relaxation and flabbiness, especially in the superficial organs.
3. Profuse secretion and exhalation.
4. Great nervous excitability with little power.

METHODS OF AUGMENTING THE TEMPERATURE OF THE BODY.—There are three modes of promoting or raising the temperature of the body:—

1. By communicating sensible heat from without, either by the application of heated substances to the body, or by the introduction of radiant heat.

2. By diminishing the cooling influence of surrounding bodies; as by the use of clothing made of substances which are bad conductors of caloric.

3. By augmenting the generation of animal heat within the body; as by active exercise, friction, and the use of medicines or foods which accelerate circulation and respiration.

Of these three methods, the first is the one which is the special object of our present inquiries.

The communication of heat to the body may be effected either by *radiation* or *conduction*. *Radiant heat* may be derived either from the sun, or from artificially-heated substances. *Conducted heat* may be derived from either dry or moist substances, and its effects vary somewhat as it comes from the one or the other of these sources.

1. Radiant heat:—
    - *a.* From the sun (*solar heat*).
    - *b.* From artificially-heated substances (*artificial radiant heat*).
2. Conducted heat:—
    - *a.* From dry substances (*dry heat*).
    - *b.* From moist substances (*moist heat*).

1. RADIANT HEAT.

1. SOLAR HEAT.—The ancients[1] were well acquainted with the salutary influence of solar heat on the human frame, and frequently employed it for therapeutical purposes.

Exposure to the solar rays, or, as it is termed, insolation (*insolatio apricatio, solicatio, heliosis* — ἡλίωσις), may be employed as a stimulant to promote circulation and warmth, in the old, debilitated, and paralytic. It is also valuable in scrofula and anæmia, and as a restorative after lingering and painful maladies.

The head should be carefully guarded from the direct influence of the sun, in order to prevent the occurrence of the *sun-stroke*, or *ictus solaris*, before referred to. The skin also should be protected, to prevent the production of erythema or erysipelas, which sometimes arises from the direct action of the sun on the naked skin.

Faure employed the solar rays, concentrated by a burning glass, to stimulate indolent ulcers, especially those which follow frost-bites. Formerly cauterisation was effected in the same way.[4]

2. ARTIFICIAL RADIANT HEAT.—Exposure to the rays of a common fire is resorted to as a stimulant and caleficient, in old paralytic and other cases attended with coldness and blueness of the extremities, and with other symptoms of insufficient circulation of the blood.

The heat radiating from a burning body (as a candle, or ignited iron), is sometimes employed as a stimulant to produce rubefaction in the tract of the vertebral column, in paralytic and neuralgic affections of the spinal cord. "A much more durable impression of heat," observes Müller,[5] "better than moxa or the actual cautery, is produced by holding a burning candle near to the affected part for a long time, so as to produce pain; by which means all the beneficial effect of heat is obtained, without the formation of an eschar and the subsequent suppuration, which is often of no service. The mode in which the caloric acts in these cases is not evident."

The radiant heat from a red-hot-iron or burning coal has been employed as a cautery to check hemorrhages, and to promote the reduction of prolapsus of the rectum and uterus, and of hernia. This practice constitutes the *cautérisation objective* of the French writers.

2. CONDUCTED HEAT.

a. *Dry Heat.*

Under the head of *dry heat* (*calor siccus*) are included hot air, bottles filled with hot water, hot sand, &c.

1. HOT AIR BATH.—Air, at a temperature of from 100° to 130° F. is stimulant and calefacient, but is less relaxing and soothing than moist vapour. When required to operate as a sudorific, a temperature from 90° to 100° F. (Dr. Gower says 85°) is found most advantageous. The hot air bath is

---

[1] Hippocrates, *De Morbis*, lib. ii. 66 and 68; Celsus, lib. i. cap. 2 and 3; Cælius Aurelianus, *Morb. Chronic.* lib. iv. cap. 2.

[2] Marjolin, in *Dict. de Médecine*, art. *Cautérisation*. Most, in his *Encyklopädie der gesammten medicin. u. chirurg. Praxis*, Leipzig, 1837, art. *Insolatio*, cites Dresig, *De solicatione, vulgo insolatione veterum*, Lips. 1737; and Richter, *Diss. Insolatio, seu potestas solis in corpus humanum*, Gotting. 1747.

[3] *Op. cit.* vol. i. p. 59.

applicable as a remedial agent when the blood has receded from the superficial parts of the body, and the internal organs are in a state of congestion; as in some forms of fever, and in spasmodic cholera; and also in asphyxia from drowning, and from some other causes But it is inferior for these purposes to either hot water or hot vapour baths. It has been used also in chronic rheumatism, in the morbus Brightii to remove the excess of water from the blood; in stiffness of the joints, and chronic skin diseases, especially the dry scaly eruptions.[1]

The *medicated hot air bath* is prepared by impregnating the hot air with some gas or vapour; as with sulphurous acid gas or chlorine.[2]

2. SOLID SUBSTANCES WHOSE TEMPERATURE DOES NOT EXCEED 100° F.—*Bottles filled with hot water* are applied to the feet to excite the circulation and augment the warmth of the body, in various diseases attended with cold extremities. The same remedy is conveniently applied to the abdomen, to remove spasmodic pain. *Hot sand* (*arena calida*), enclosed in a bag or bladder, may be employed for similar purposes. It is used as a bath[3] in the maritime departments of the South of France.[4] It operates as a stimulant and sudorific, and is employed in rheumatism, spasm, paralysis, &c.[5] *Hot ashes* or *bran* have been applied to similar uses; as also *hot bricks*. *The leaves of the common birch* (*Betula alba*) are employed in Sweden.[6]

The animal heat of young and healthy persons (*acubitus junioris*) has also been employed in cases of extreme exhaustion with great depression of the temperature of the body, especially in the aged. It is a very ancient practice, having been adopted in the case of King David.[7] Sydenham was particularly partial to it, and speaks of its efficacy with great confidence. He says the heat applied by it is more agreeable, bland, moist, equal, and permanent than that of hot clothes.[8] *The warm skin of a recently-killed animal*, particularly that of a sheep, wrapped round the body of the patient, the wool outwards, has likewise proved advantageous.[9]

---

[1] For further information respecting the hot air bath, consult the *Cyclopædia of Practical Medicine*, vol. i. p. 266, art. *Warm-Air Bath*, by Dr. Forbes.—Also Dr. Gower's *Auxiliaries to Medicine*, Lond. 1819, Tract 1, *An Account of the Sudatorium*.

Various easy modes of making a hot air bath have been suggested. A very simple method is that recommended by Mr. Alcock (*Lancet*, 1825-6, vol. ix. p. 862). It consists in burning spirit in a cup or saucer under a blanket; the patient lying on the bed with his head and face outside the blanket, as the air is not fit for respiration. The blanket is supported over the bed by a cord.

[2] See *Chlorine* and *Sulphurous Acid*.

[3] The phrase *balneum arenæ* is incorrect. Celsus (lib. ii. cap. 17) limits the term *balneum* to a water-bath artificially heated in a private house.

[4] Schwilgue, *Traité de Matière Médicale*, t. ii. p. 324.

[5] The practice of sand-bathing, called *saburration* or *arenation* (*saburratio*, *arenatio*, vel *psammismus*, ψαμμισμός from ψάμμος, sand,) is very ancient (Quiring, *De balneis arte parandis. Diss. Inaug.* Berol. 1837; Sutherland, *Attempts to revive Antient Medical Doctrines*, vol. i. p. 48, Lond. 1763). It is allied to mud-bathing or *illutation* (*illutatio*), hereafter to be noticed. Lind (*Treatise on the Scurvy*, 3d ed. 1772, p. 534,) mentions a common practice among the Buccaneers, in the West Indies, of *burying in the ground* (the head being left above ground) patients affected with scurvy. They were permitted to remain thus interred for several hours, until a profuse sweat ensued. I have recently had under my care, in the London Hospital, a sailor who had been twice thus buried in the West Indies for the cure of scurvy!!

[6] Bergius, *Materia Medica*, t. ii. 778, ed. 2da, Stockh. 1782.

[7] 1 *Kings*, ch. i. 1–4.

[8] Sydenham, *Opera omnia*, ed. G. A. Greenhill, M.D. Lond. 1844, p. 55.—Also *Anecdota Sydenhamiana*, p. 62, Oxford, 1845.

[9] Copland, *Dict. of Pract. Med.* vol. iii. p. 135.

3. METAL HEATED TO 212°.—The late Sir Anthony Carlisle[1] proposed to excite speedy vesication by the application to the skin of a polished plate of metal heated to 212° by immersion in boiling water. He recommended it as a substitute for cantharides, than which he declared it to be less painful; while it is not liable to cause strangury.

4. THE ACTUAL CAUTERY (*Cauterium actuale*).—Several agents have been employed as actual cauteries; viz. *red-hot iron*, *moxa*, and the *flame of hydrogen*. The first, however, is the one generally referred to under the name of the actual cautery. The two latter will be noticed in subsequent parts of the work.[2]

In this country the actual cautery (red-hot iron) is seldom used. It is sometimes resorted to as a styptic, when the hemorrhage is from a great number of small vessels, or from a vessel so situated that the ligature cannot be applied. It is also used to destroy morbid growths which cannot be reached by the knife—as fungus of the antrum; to stop caries, to excite an artificial ulcer, to open abscesses, to close fistulous ulcers, to decompose the venom or poison in bites by poisonous or rabid animals, to remove nævi, and, in epilepsy, to destroy the part from whence the aura epileptica sets out.[3]

b. *Moist Heat.*

Under the head of *moist heat* (*calor humidus*) are included *warm aqueous vapour*, *warm water*, and *warm moist solids*.

α. Aqueous Vapour.

1. THE VAPOUR BATH.—The general effects of the vapour bath are those of a powerful stimulant and sudorific. It softens and relaxes the cutaneous tissue, expands the superficial vessels, accelerates the circulation of blood, augments the frequency of the pulse and respiration, and produces copious perspiration. These effects are succeeded by a feeling of languor, and a tendency to sleep.

If the whole body be immersed in vapour, which is consequently inhaled, the temperature should be a little less than if the trunk and limbs alone are subjected to its influence; because the inhalation of vapour stops the cooling process of evaporation from the lungs. The following is a comparative view of the heating powers of water and of vapour, distinguishing the latter according as it is or is not breathed:[4]—

	WATER.	VAPOUR.	
		Not breathed.	*Breathed.*
Tepid bath	85° — 92°	96° — 106°	90° — 100°
Warm bath	92 — 98	106 — 120	100 — 110
Hot bath	98 — 106	120 — 160	110 — 130

---

[1] *Lancet*, 1826-27, vol. xi. p. 315 and 384.

[2] See *Hydrogen*, and *Artemisia Moxa*.

[3] For further details respecting the actual cautery and cauterisation, see Percy's *Pyrotechnie chirurgicale pratique*, Paris, 1811; Marjolin, art. *Cautère* and *Cautérisation*, in the *Dict. de Médecine*; and Sanson, in the *Dict. de Méd. et Chir. pratiques*.

[4] Dr. Forbes, *Cyclopædia of Practical Medicine*, art. *Bathing*, vol. i. p. 265.

The vapour bath is distinguished from the hot air bath by its soothing, relaxing, and greater sudorific influence; from the hot-water bath, by its inferior power of communicating heat, by its greater sudorific tendency, and by its causing scarcely any superficial compression of the body, whereby it does not occasion the præcordial oppression experienced on entering the water bath. [The opinion here expressed with respect to the sudorific influence of the vapour bath being greater than that of the hot-air bath, admits of controversy. Theoretically, the hot and *dry* air would appear to call upon the cutaneous surface for greater transudation than hot air saturated with moisture; and the very powerful effects obtained in practice when using the hot-air bath for the relief of dropsical swellings, also favours the opinion that the hot-air bath is a more powerful sudorific than the vapour bath.—ED.]

The vapour bath, like the hot air bath, may be employed when the blood has receded from superficial parts, and congestion of internal organs has in consequence occurred; as during the cold stage of intermittent fever, in malignant cholera, and during the stage of chilliness which ushers in various febrile complaints. But its great value is experienced when our object is to relax the skin, and to produce profuse sweating; as in chronic rheumatism and gout, in slight colds from checked perspiration, and in chronic skin diseases accompanied with a dry state of the cutaneous surface. In old paralytic cases, without signs of vascular excitement of the brain; in some uterine affections, as chlorosis, amenorrhœa, and irritation of the womb; in dropsy of aged and debilitated subjects; in old liver complaints; and in some scrofulous affections, it is occasionally employed with advantage.[1]

In this country it is employed for therapeutic purposes only; but in Egypt, Turkey, Persia, and some other parts of the East, and in Russia, it is in common use as a hygienic agent and luxury, and is accompanied by a process of friction, kneading, and extension of the muscles, tendons, and ligaments, constituting the *massing*[2] of the Egyptians, and the *shampooing* of the East Indians. In rigidity and stiffness of joints this process sometimes proves of considerable service.

The *Russian vapour baths* have been long celebrated. The vapour is produced by throwing water over red-hot stones. Its temperature, according to Lyall,[3] is from 122° to 144·5° F. Besides being exposed to the influence of this vapour, the bathers are subjected to a system of friction, flogging with the leafy branches of the birch, and affusions of warm or cold water. It is customary with them to issue from their bathing-houses, while quite hot, and, in the summer, to plunge into cold water,—in the winter to roll themselves naked in the snow, without sustaining injury or ever catching cold.[4] Bremner[5] describes the supposed bracing effects as being all imaginary; and declares that the practice of bathing followed by the Russians rapidly enervates and undermines the constitution. Several medical writers[6] have borne testimony to the efficacy of the baths in alleviating rheumatism.

---

[1] For a more detailed account of the uses of the vapour bath, the reader is referred to Dr. Gibney's *Treatise on the Properties and Medical Application of the Vapour Bath*, Lond. 1825.

[2] *Masser*, from the Arabic verb *masses*, to touch lightly. See Savary's *Letters on Egypt*, vol. i. p. 130, 2d edit. Lond. 1787.

[3] *Character of the Russians*, p. 112, Lond. 1823.—Mr. Lyall has given a plan of the Russian baths.

[4] Dr. E. D. Clarke's *Travels in various Countries of Europe*, part i. p. 143 et seq.

[5] *Excursions in the Interior of Russia*, vol. i. p. 185, Lond. 1839.

[6] Dr. Granville's *St. Petersburgh*, vol. i. p. 509, Lond. 1828.

The *Egyptian vapour baths* are in constant and general use. The bathers, having been subjected to the operation of *massing* already alluded to, are then rubbed, and afterwards washed.[1] The *Turkish*[2] and *Persian*[3] baths are somewhat similar.

Topical or *local vapour baths* are employed in the treatment of local diseases; as affections of the joints. Dr. Macartney[4] recommends the topical use of vapour, as a soothing and anodyne application, in painful wounds, contusions, and fractures.

The *vapour douche* is a jet of aqueous vapour (whose temperature does not exceed that of a general vapour bath) directed on some part of the body. Its action depends principally on the temperature of the fluid, for its mechanical effects are comparatively trifling. In some affections of the ear, as otitis, otorrhœa, and otalgia, a stream of warm aqueous vapour may be introduced into the meatus auditorius externus with considerable relief. The most ready means of effecting it is by a funnel inverted over a vessel of hot water; the meatus being applied to the orifice of the funnel.

The *medicated vapour bath* is prepared by impregnating aqueous vapour with the odour of medicinal plants.

Sulphurous acid gas, *chlorine gas*, and *the vapours of sulphur, iodine, camphor*, &c. are sometimes employed in conjunction with aqueous vapour: their effects will be described hereafter.

The application of vapour to particular parts of the body has in some cases been accompanied with the simultaneous removal of atmospheric pressure, constituting the *air-pump vapour bath;* which has been employed in gout, rheumatism, and paralysis[5].

2. INHALATION OF WARM VAPOUR.—The inhalation of warm aqueous vapour proves highly serviceable, as an emollient remedy, in irritation or inflammation of the tonsils, or of the membrane lining the larynx, trachea, or bronchial tubes. It may be employed by Mudge's inhaler, or by inspiring the vapour arising from warm water. Various narcotic and emollient substances are frequently added to the water, but without adding much, if any thing, to its therapeutical power. Dr. Paris[6] states that, in some pulmonary complaints, he has been long in the habit of recommending persons confined in artificially-warmed apartments to evaporate a certain portion of water, whenever the external air has become excessively dry by the prevalence of the north-east winds which so frequently infest this island during the months of spring; and the most marked advantage has attended the practice. In rooms artificially heated by hot air stoves, the necessity for this proceeding is still more obvious.

---

[1] For a description and representation of the Egyptian baths, consult *Description de l'Egypte, État moderne*, t. ii. (2de partie), p. 683; vol. i. planche 49, and vol. ii. planche 94. Also, Lane's *Account of the Manners and Customs of the Modern Egyptians*, vol. ii. p. 35, Lond. 1837.—Sir J. G. Wilkinson, in his *Manners and Customs of the Ancient Egyptians*, vol. iii. p. 388, Lond. 1837, has given a sketch, from a painting in a tomb at Thebes, representing a lady in a bath, with four attendants.

[2] D'Ohsson's *Tableau Général de l'Empire Ottoman*, t. i. p. 160, Paris, 1787. An engraving of a bath is given.

[3] *Fowler's Three Years in Persia*, vol. i. p. 269, Lond. 1841.

[4] *A Treatise on Inflammation*, p. 176, Lond. 1838.

[5] *Facts and Observations respecting the Air-Pump Vapour Bath in Gout, Rheumatism, Palsy, and other Diseases*, by Ralph Blegborough, M.D. Lond. 1803. La Beaume, *Observations on the Air-Pump Vapour Bath*, Lond.

[6] *Pharmacologia*, vol. i. pp. 198 and 379, 6th edit. Lond. 1825.

The benefit which pulmonary invalids are said to have derived from a *residence in cow-houses*[1] is principally referable to the moist warm air with which such places are filled[2].

3. STEAM.—Steam is sometimes employed as a powerful rubefacient and caustic. It is applied by a small copper or tin boiler, called an *æolopile* (from *Æolus*, the god of wind, and *pila*, a ball), furnished with a tubular mouth and stop-cock, and heated by a spirit-lamp. Its action on the body is limited by a perforated piece of pasteboard. When applied sufficiently long, it causes an extensive and deep eschar. In this respect its action is similar to that of boiling water, from which it principally differs in the circumstance of having a much larger quantity of specific and latent heat, but a less conducting power; and in the greater facility with which we can limit its effects. It greatly resembles moxa; but its action is less readily localised, and the wound which it causes is less manageable. It has been used as a powerful counter-irritant in diseases of the hip-joint, neuralgic pains, chronic rheumatism, &c. The objections to its employment are the great pain which it causes, and the danger of its effects.

β. Warm Liquids and Moist Solids.

1. BATHS OF TEPID, WARM, OR HOT WATER.—The practice of bathing is of great antiquity, and precedes the date of our earliest records. It was adopted sometimes for the purpose of cleanliness, sometimes for the preservation of health, and frequently as a recreation and luxury. The ancient Hebrews[3] practised ablutions and bathing; as did also the Greeks. Homer[4] on various occasions mentions hot baths and ablutions; and in the writings ascribed to Hippocrates[5], we find baths mentioned, and their effects described. They are also noticed by Celsus[6], Pliny[7], and other Roman writers. Prosper Alpinus[8] says, that the Egyptians employed hot baths for cleanliness and health; and Freind states, that when Alexandria was plundered, in A.D. 640, there were 4000 baths in that city[9]. Among the Persians[10] and Arabians[11] baths were in use; and the ancient Hindoos also employed them[12].

These examples sufficiently establish the great antiquity of the practice of bathing[13].

---

[1] See Dr. Beddoes' *Observations on the Medical and Domestic Management of the Consumptive, on the Digitalis purpurea, and on the Cure of Scrophula*, Lond. 1801.

[2] See Vogt's *Lehrbuch der Pharmakodynamik*, 2er Band, S. 32, 2te Aufl. Giessen, 1828.

[3] *Leviticus*, xiv. 8; 2 *Kings*, v. 10. *Bell. Jud.* lib. i. cap. 33, § 5.

[4] *Iliad*, xxii. 444; *Odyss.* viii. 451. It would appear from Homer, that the offices of the baths were performed by females; though, from a passage in Herodotus (vi. 19), we may infer that this custom was not peculiar to the Greeks.

[5] *De Diæta*, lib. ii. § 35; *De Affectionibus*, § 47.

[6] Lib. i. cap. 3; and lib. ii. cap. 17.

[7] *Hist. Nat.* lib. xxix. cap. 8; and lib. xxxi. cap. 2, et seq. edit. Valp.

[8] *Medicina Ægyptiorum*, lib. iii. capp. 14–19.

[9] *History of Physick*, part i. p. 7, 3d edit. Lond. 1727.

[10] Xenophon, *Cyropædia*, lib. viii. Plutarch, in his Life of Alexander the Great, mentions that this celebrated conqueror was astonished at the sight of the baths of Darius.

[11] Avicenna, *Canon*, lib. iii. fen. xvi. tract. iv. cap. 10.

[12] Royle's *Essay on the Antiquity of Hindoo Medicine*, p. 53, Lond. 1837.

[13] For further information respecting ancient baths, consult *An Account of the Ancient Baths, and their use in Physic*, by T. Glass, M.D. Lond. 1752; and *Attempts to revive Ancient Medical*

a. The Tepid Bath has a temperature of from 85° to 92° F. It gives rise to a sensation of either heat or cold, according to the temperature of the body at the time of immersion. It cleanses the skin, promotes perspiration, and allays thirst. It is sometimes employed as a preparative to the temperate, cool, or cold bath. When there is a tendency to apoplexy, the simultaneous immersion in the tepid bath, and affusion of cold water over the head, have been recommended.

b. The Warm Bath has a temperature of from 92° to 98° F. In general it causes a sensation of warmth, which is more obvious when the body has been previously cooled. It renders the pulse fuller and more frequent, accelerates respiration, and augments perspiration. It causes languor, diminution of muscular power, faintness, and a tendency to sleep. As a relaxant, it is employed to assist reduction in dislocations of the larger joints, and in herniæ. In the passage of calculi, whether urinary or biliary, it is used with the greatest advantage: it relaxes the ducts, and thereby alleviates the pain, and facilitates the passage of the concretion. In gastritis, enteritis, cystitis, and nephritis, it proves a valuable and powerful agent. In exanthematous diseases, when the eruption has receded from the skin, in chronic cutaneous diseases, rheumatism, amenorrhœa, and dysmenorrhœa, it is highly serviceable.

The *coxælucium*, or *hip-bath*, is resorted to in inflammatory or spasmodic affections of the abdominal and pelvic viscera, and in amenorrhœa and in dysmenorrhœa. It is also sometimes employed as a substitute for the general bath, where some affection of the lungs, heart, or great vessels, prohibits the use of the latter. The *bidet* is employed in piles, prolapsed rectum, strangury, ischuria, &c. The *pediluvium*, or *foot-bath*, is used as a revulsive or counter-irritant, in slight colds; to promote the menstrual and hæmorrhoidal discharges; and for various topical purposes. The *brachiluvium* or *arm-bath*, and *manuluvium* or *hand-bath*, are principally applied in topical affections of the upper extremities.

c. The Hot Bath has a temperature of from 98° to 112°. It causes a sensation of heat, renders the pulse fuller and stronger, accelerates respiration, occasions intense redness of the skin, and subsequently copious perspiration; gives rise to violent throbbing, and a sensation of distension of the vessels of the head, with a feeling of suffocation and anxiety. Long immersion in it sometimes causes apoplexy. Being a powerful excitant, its use requires caution. It is principally employed in paralysis, rheumatism, and some other chronic diseases, also in collapse, &c.

The above remarks apply to common or fresh water baths; but *sea water*, *mineral waters*, and various *medicated waters*, are employed for general or topical baths. Of the medicated water baths, those in most frequent use are the *nitro-muriatic*, the *ioduretted*, the *salt water*, the *alkaline*, and the *alkaline sulphuretted*. These will be described hereafter. A *decoction* or *infusion of bran*, and a *solution of bichloride of mercury*, have been used as pediluvia. *Milk* and *gelatinous liquids* are employed as nourishing baths. *Blood*, and *the soft parts of recently killed animals*, were formerly used as baths (*balnea animalia*).[1]

Mud-bathing, or *illutation* (*illutatio*, from *in*, upon, and *lutum*, mud), is a very ancient

---

Doctrines, by Alexander Sutherland, M.D. vol. i. p. 12, et seq. Lond. 1763. Also, *De Balneis omnia quæ extant apud Græcos, Latinos et Arabas*, Venet. 1553; and Montfauçon, *L'Antiquité expliquée et représenté en Figures*, t. iii. part ii. p. 204, 2nde édit. Paris, 1722.

[1] See p. 16. Also, Quiring, *op. supra cit.*

perspiration.[1] The slime of the Nile was formerly in great request for this purpose.[2] The saline sand found on the sea-shore has been employed in very hot weather as a bath, by the inhabitants of Crimea, and especially by the Tartars, against hypochondriasis, scurvy, scrofula, &c. It operates as an excitant and sudorific.[3] *Hot dung* is used in France as a kind of bath against rheumatism, and in Poland against syphilis.[4] *The husk of the grape, and the refuse of the olive*, from which the oil has been drawn, undergo fermentation, and in this state have been successfully employed in Paris against acute rheumatism.[5]

2. WARM AFFUSION.—Warm affusion excites a very unpleasant sensation, followed by chilliness, and often by pulmonary affections. It has, however, been used in mania. It reduces the frequency of the pulse and of respiration, and occasions a tendency to repose; but its effects are much more temporary than those of the warm bath.[6]

3. WARM FOMENTATIONS AND POULTICES.—*Warm fomentations* are employed to lessen inflammation, and to relieve pain, tension, and spasm. In inflammation of the abdominal and pelvic viscera, and in strangury, they are highly serviceable. My friend and colleague, Mr. Luke, has for several years employed, at the London Hospital, warm water as an emollient application to burns and scalds. In almost every instance it soothes and mitigates pain. Mr. Luke thinks that it exerts a beneficial influence in mitigating the consecutive inflammation, rendering the after consequences less severe locally, and the reparative process more speedy, than under other modes of treatment. The water has generally been used in the form of fomentations: repeatedly changing the flannels, and taking care that the surface of the skin was exposed to the air as little as possible. But in some cases poultices have also been adopted, and with much benefit, although their weight, when large, has rendered them not so convenient as fomentations; they obviate, however, the evil arising from the frequent renewal of the latter, and the consequent mechanical irritation.

Emollient poultices act as a kind of local bath. They are employed to relieve pain, spasm, and tension, and to promote the termination of inflammation by resolution or suppuration.

A kind of cloth, called *Impermeable Spongio Piline*, composed of a mixture of sponge and wool, felted together so as to form an even and soft fabric, and afterwards rendered waterproof by a coating of caoutchouc, has been recently introduced as a substitute for poultices and fomentation cloths.

4. WARM AQUEOUS DRINKS AND INJECTIONS.—Tepid or warm water is *taken into the stomach* to promote vomiting; to dilute the contents of the stomach, in cases of poisoning by acrid substances; to excite diaphoresis, in rheumatism, catarrh, gout, &c.; and to allay troublesome cough, especially when dependent on irritation at the top of the larynx. Warm water is *injected into the rectum* to excite alvine evacuations; to promote the hemorrhoidal flux; to diminish irritation in the large intestine, or in some neighbouring organs, as the uterus, bladder, prostate gland, &c.; and to bring on the menstrual secretion. *Thrown into the vagina*, it is used to allay uterine

---

[1] See *Sand-bathing*, p. 16, foot-note.
[2] Aetii, *Serm.* i. cap. 1 et 3. Sutherland, *op. supra cit.* vol. i. p. 45, Lond. 1763.
[3] *Bull. des Sc. Méd. de Ferussac*, xiii. 179.
[4] Mérat and De Lens, *Dict. de Mat. Méd.* art. *Bain.*
[5] *Ibid.*
[6] For further details respecting *Affusion*, see p. 29.

irritation and pain, and to promote the lochial discharge. *Injected into the bladder*, it is sometimes employed to relieve vesical irritation, to distend the bladder previously to the operation of lithotrity, or when exploring for calculi. It has also been *injected into the urethra*, to allay pain, irritation, inflammation, and spasm.

Lastly, Magendie *injected warm water into the veins*, in hydrophobia, but without saving the life of the patients. I have repeated the experiment, but without any successful result. The same remedy has been employed by Vernière,[1] to distend the venous system, and thereby to check or stop absorption, in cases of poisoning by those substances (opium for example,) which operate by getting into the blood. Moreover, warm water is sometimes used as a medium for the introduction of more powerful agents (as emetic tartar) into the circulating system.

5. BOILING WATER.—Water at the temperature of 212° F. is a powerful irritant, vesicant, and cautery; its effects are similar to those of steam, before mentioned. It has been applied to the skin as a powerful counter-irritant in maladies of internal organs, and as a speedy vesicant when the object is to introduce medicinal substances (morphia for example,) into the system by the cutis vera. But the excesssive pain which it gives rise to, the uncertainty of its effects, and the difficulty of localising its action, are great and almost insuperable objections to its use. [It may occasionally save life by producing rapid vesication in cases of acute laryngitis, and in the œdema of the glottis so often fatal in the morbus Brightii.—ED.]

3. FRIGUS.—COLD.

PHYSIOLOGICAL EFFECTS.—The general effect of cold on living bodies is a diminution of vital activity; which terminates, if the cold be intense, and its application continued, in death.

The influence of cold is threefold:—

1. PHYSICAL; including *diminution of volume, of temperature*, and *of fluidity*.
2. CHEMICAL; comprising *a diminished tendency to changes of composition*, and *to decomposition*.
3. DYNAMICAL, PHYSIOLOGICAL, or VITAL; comprehending *changes in the condition of the vital properties*.

a. On Vegetables.—The effects of cold on plants are greater in proportion to the combined humidity. The first effect is a certain state of languor or torpor manifested in germination, the growth and development of all the vegetable organs, inflorescence, fecundation, and maturation of the fruit. Cold also favours the disarticulation of articulated parts. Lastly, by an intense frost the aqueous juices freeze: an effect which is often attended with the death of part or the whole of a plant.[2]

b. On Man and other Animals.—The effects of cold on animals are two-fold, viz.:—

1. Direct, primary, or immediate.
2. Indirect, secondary, or mediate.

---

[1] Christison's *Treatise on Poisons*, p. 35, 3d edit. 1835.

[2] De Candolle, *Physiologie Végétale*, t. iii. p. 1117, Paris, 1832.

The direct or primary influence of cold is diminished vital activity. The indirect or secondary influence of moderate cold, applied temporarily, is increased activity of the vital powers, or re-action.

α. Topical Effects of Cold.—The first effect of the application of a cold substance to the body is a sensation of cold, the intensity of which depends on four circumstances, viz.:—

1. *On the temperature of the cold substance.*

2. *On the conducting power of the cooling agent.* Thus, "if, in winter, a person with bare feet were to step from the carpet to the wooden floor, from this to the hearth-stone, and from the stone to the steel fender, his sensation would deem each of these in succession colder than the preceding. Now the truth being that all had the same temperature, only a temperature inferior to that of the living body, the best conductor, when in contact with the body, would carry off heat the fastest, and would, therefore, be deemed the coldest."[1]

3. *On the previous heat of the living surface.* Thus, a substance having a temperature of 60° F. will feel warm to the hand or other living part previously exposed to a temperature of 32° F., but cold to a part which immediately before was exposed to a heat of 96° F. or 98° F.

4. *On the frequency of renewal of the cooling agent.* Thus, the air feels much colder in blowing or windy weather than in a calm and still condition of the atmosphere, although the actual temperature, as determined by the thermometer, may, in the two cases, be the same.

The sensation of cold is soon followed by a reduction of temperature, and a diminution of volume of the part. This last effect is partly physical, partly vital. Of course the solids and fluids of the body, in common with inorganised substances, must have their bulk reduced when their temperature is diminished; but a living part lessens in size from a vital manifestation—viz. the contraction of the living tissues. This contraction, or astriction, is especially manifested in the skin when exposed to a cooling influence. The cutaneous tissue becomes dry and shrivelled, while the bulbs of the hairs become elevated and manifested; constituting the state called goose-skin (*cutis anserina*). The muscular tissues become rigid or spasmodically contracted; and this effect extends by sympathy to other muscular parts beyond those to which the cold is applied. The blood-vessels, in common with all other living parts, suffer contraction; and the quantity of blood circulating in them is thereby lessened, while its motion is retarded. The secretions and exhalations are checked or stopped; partly as a consequence of the effect on the circulation of the part, partly by the contraction of the secreting and exhaling organs. If the cold be excessive, or its action prolonged, the part, after suffering more or less uneasiness, loses its sensibility. This state of torpefaction or benumbing, when fully established, is denominated *frost-bite*, and, unless speedily relieved, is followed by the death of the part.

"I perceived one day on a journey," says Beaupré,[2] "that two officers, prisoners of war, and my companions in misfortune, had the points of their noses of a horn white, the colour of old wax. I warned them, and frictions with snow were sufficient to remove this first stage of congelation, which they had not suspected. But what appeared to them very singular was, that, while I gave them advice, I myself needed the same—my nose was in the same condition; *sibi non cavere et aliis consilium dare.* From that moment we were on the alert; we kept on our guard; and, that we might not fall victims to a security alike fatal and involuntary, each begged his neighbour, on terms of reciprocal service, to watch over his nose and ears."

---

[1] Arnott's *Elements of Physics*, vol. ii. part 1, p. 25, Lond. 1829.

[2] *Treatise on the Effects and Properties of Cold*, translated by Dr. Clendinning, p. 132, Edinb. 1826.

"After entire cessation of pain, the part remains cold and insensible; sometimes phlyctenæ arise; sometimes the change of colour in the skin, which is livid and blackish, evinces from the commencement that there is mortification."[1]

If the cold be either moderate or only temporarily applied, reaction is readily induced. The disagreeable feeling of cold is succeeded by an agreeable sensation of warmth; the natural temperature returns, relaxation takes place, and the parts acquire their usual volume, colour, and sensibility. When the cold to which the part has been exposed is excessive, and the heat subsequentlly employed to excite reaction be too suddenly applied, inflammation and even gangrene ensue.

Pernio, or *chilblain*, is an inflammatory disease, caused by cold.

That gangrene and death readily result from the sudden application of warmth to a frozen part, was known to Hippocrates,[2] who states that a man having had his feet frozen, lost them by the application of warm water.

The true method of recovering frost-bitten parts consists in very gradually restoring their natural temperature by the use, first, of snow or ice frictions, then of cold water, and subsequently of luke-warm water.

β. *Effects of cold applied to the whole body.*—Temporary exposure to moderately cold air (from 30° to 45° F.) is agreeable, and, by the reaction which it establishes, exciting to the young and the vigorous. The coldness of surface and diminished capillary circulation, which it at first occasions, are soon followed by reaction, especially if exercise be conjoined. A more intense or a longer continued cold causes shivering, goose-skin, determination of blood to internal organs, coldness of surface, and a kind of spasmodic rigidity. These effects are much more severely experienced by the old, the debilitated, and the paralytic.

When the degree of cold is excessive, or its application too prolonged, it causes torpor, irresistible tendency to sleep, a kind of apoplectic condition, asphyxia, and death.[3]

The diseases produced by cold are numerous.[4] Chilblains and frost-bites have been already referred to. Pulmonary affections are by far the most common of the internal maladies induced by cold. Scrofula is a disease of cold and moist climates. Rheumatism is another malady brought on by cold and moisture conjoined. Apoplexy and paralysis, especially in the aged, are

---

[1] *Treatise on the Effects and Properties of Cold*, translated by Dr. Clendinning.

[2] *De Usu Liquidorum*, p. 425, ed. Fœsii.

[3] A remarkable and well-known instance of the strong tendency to sleep induced by cold occurred in one of Captain Cook's voyages (Hawkesworth's *Account of the Voyages of the Southern Hemisphere*, vol. ii. p. 46, Lond. 1773).—In both ancient and modern times military expeditions have furnished dreadful and notorious illustrations of the disastrous effects of cold, combined with other influences, on the human frame; as in the case of the Greeks under the command of Xenophon (*Cyropædia*, lib. iv.), and twice under the command of Alexander the Great (Pratt's Translation of Quintus Curtius's *History of Alexander the Great*, vol. ii. pp. 157 and 233, revised edit, 1821); of the Swedes, in 1719 (*Hist. Register* for 1719, vol. iv. pp. 308–310); of the French in 1742 (Beaupré, *op. cit.* p. 96), and in 1812 (Count Segur's *History of the Expedition to Russia undertaken by the Emperor Napoleon in* 1812, Lond. 1825; Beaupré, *op. supra cit.* p. 93; Sir Henry Halford, *Lond. Med. Gaz.* vol. xix. p. 903); and of the British in Affghanistan in 1841-2 (Eyre, *Military Operations at Cabul*, Lond. 1843).

[4] See Dr. Clendinning, in the *Lond. Med. and Phys. Journ.* for June, July, and Sept. 1832.

are occasioned by cold.[1] In addition to the diseases now mentioned, there are many others, the progress of which is more or less promoted by cold.

On examining the bodies of persons killed by cold, congestion of the cerebral vessels, and effusion into the ventricles of the brain,[2] have always been found.

Uses.—We employ cold for the purpose of obtaining its primary, or its secondary effects.[3]

α. *Uses of the Primary Effects of Cold.*—The primary action of cold is that of a depressing and sedative agent. When we use it therapeutically, we employ a more intense degree of cold, or continue its application for a longer period, than when we resort to cold for its secondary effects.

As a remedial agent, the primary effect of cold serves several important purposes, of which the following are illustrations:—

1. To lessen vascular and nervous excitement, and preternatural heat.

a. To lessen preternatural heat. *Examples.*—Cool air and cold sponging in ardent fever; cold lotions in headache with augmented heat of head.

b. To reduce vascular action. *Examples.*—Cold lotions or the ice-cap to the head in phrenitis; cold washes to inflamed parts. Cold applications are "with greater propriety employed before inflammatory action is fairly established; and they act by constringing the superficial vessels, with which those more deeply seated sympathise to a certain extent; but warm fomentations are more pleasant and useful when inflammation has really taken place."[4]

c. To lessen nervous excitement, especially when conjoined with increased vascular action. *Examples.*—The ice-cap to relieve the low maniacal delirium of typhus fever; and the shower-bath, cold affusion, and the douche, in paroxysms of excitement in cases of insanity.

2. To constringe living tissues, to promote the coagulation of the blood, and to lessen the volume of parts.

a. To check hemorrhage. *Examples.*—Cool air, cold water, and ice to stop bleeding from numerous small vessels. In these cases the cold acts by causing contraction of the wounded extremities of the vessels, and by promoting the coagulation of the blood.

b. To promote the spontaneous cure of aneurism. *Example.*—Iced water and pounded ice to aneurismal tumours. Cold is employed, in these cases, with the view of restoring the elasticity of the arterial coats, and of promoting the coagulation of the blood within the aneurismal sac.

c. To promote the reduction of strangulated herniæ. *Example.*—Cold produced by the evaporation of ether applied to the hernial tumor; or the continued application of the ice poultice (pounded ice, or a freezing mixture, contained in a bladder,) to the part. Cold is used in these cases, with the view of lessening the volume of the hernial tumour, which it may effect partly by constringing the living tissues, partly by causing a physical diminution of bulk of the contents of the hernial sac; but its efficacy is deserving of little faith.

3. To alleviate pain.

In slight burns or scalds, immediate relief from pain is obtained by plunging the part in cold water. Cardialgia is sometimes relieved by the internal use of ice or ice-cold water.

β. *Uses of the Secondary Effects of Cold.*—The secondary effects

---

[1] *Dict. of Pract. Medicine*, art. *Cold*, by J. Copland, M.D.

[2] Kellie. *Trans. of the Medico-Chirurgical Society of Edinburgh*, vol. i. p. 84.

[3] Gallot, *Diss. Inaug. de Frigoris Usu Therapeutico*, Berol. 1838.

[4] Liston, *Elements of Surgery*, p. 20, 2d edit. 1840.

(commonly termed *reaction*) of cold are the opposite of the primary effects. When we desire to obtain them for therapeutical purposes, we employ cold of less intensity, or for a shorter period, than when we wish to procure the primary effects. Moreover, mechanical concussion is frequently conjoined, as in the shower bath, the douche-bath, and cold affusion.

They are employed for several purposes, of which the following are illustrations:—

1. To strengthen and give tone to the system.

Examples.—The shower-bath and cold plunge-bath are used as ordinary hygienic agents to promote health and strength.

2. To make a sudden and powerful impression on the system.

a. To interrupt the progress of fever. *Example.*—Cold affusion has, in some cases, cut short fever at once; a disposition to sleep and sweating has ensued, and the patient has awoke almost free from disease.

b. To act on the excito-motory system. *Examples.*—Cool air, aspersion of cold water, and cold affusion in syncope, spasmodic closure of the glottis, hysteria, epilepsy, poisoning by hydrocyanic acid, opium, &c. Cold, in these cases, excites a sudden act of inspiration. "The influence of cold water dashed on the face, and the influence of the diffused contact of the cold bath, in exciting sudden sobbing acts of inspiration, are well known."[1] [It has also been recommended, and with great show of reason, to dash cold water over the faces of children stillborn, and also of persons drowned, with the view of exciting the respiratory act after the body has been warmed.—ED.]

3. To recall the vital properties to frost-bitten parts.

In the treatment of frost-bite, the object to be obtained is the very gradual restoration of the part to its normal state, by the use, in the first instance, of the lowest degree of warmth, and, subsequently, of gradually augmented warmth.

4. To effect local excitation.

Examples.—Local douches or pumping in old rheumatic and paralytic affections, stiff joints, &c.

CAUTIONS.—In the use of ice, ice-cold water, and freezing mixtures, some caution must be exercised, lest the cooling effect be carried too far. Nurses frequently err from ignorance, on this point. The head and other parts of the body are frequently cooled down below the healthy standard, and, in some cases, death and sloughing of the integuments are thereby produced.

In persons disposed to apoplexy, and in patients affected with maladies of the heart or lungs, cold bathing, especially in those unaccustomed to it, or in those whose circulation is feeble, is by no means devoid of danger.

METHODS OF COOLING THE BODY.—There are two methods of lowering the temperature of the body:—

1. By diminishing the amount of animal heat generated in the system; as by starvation, inactivity, loss of blood, and, perhaps, by the medicinal substances termed sedatives and refrigerants.
2. By the abstraction of heat from the body.

Of these two methods the latter is the special object of our present inquiries, and requires further examination.

---

[1] Dr. Marshall Hall, *On the Diseases and Derangements of the Nervous System*, p. 114, Lond. 1841.

The abstraction of heat from the body may be effected in three ways :—

1. By promoting the radiation of heat from the surface of the body.
2. By promoting evaporation from the surface of the body.
3. By conduction, or the contact of cold substances.

1. COLD BY RADIATION.

Heat radiates from all bodies, but unequally so : the hotter body, *cæteris paribus*, evolves more heat by radiation than the colder one. Hence, by exposure to cool air, the naked body is cooled partly by radiation, partly by the contact of the particles of cold air with the cutaneous surface. Clothing acts as a screen, and checks radiation and the contact of cold air.

On many occasions we avail ourselves of these circumstances, and use radiation as a means of cooling the living surface. Thus hemorrhage is frequently checked by exposing the bleeding surface to the cold air ; and cerebral vascular excitement is lessened by uncovering or shaving the head.

2. COLD BY EVAPORATION.

The conversion of a liquid into a vapour is attended with the absorption of heat. Hence if, at the surface of the body, evaporation be effected, cold is produced. The use of ethereal, alcoholic, and aqueous evaporating lotions, to relieve local irritation and superficial inflammation, is so familiar to every one, as scarcely to require notice. Circumstances which promote evaporation augment the intensity of the cold. Thus fanning or blowing the part increases the cold by effecting a more rapid evaporation of the lotion. The application of these liquids should be effected by means of a single layer of thin muslin or linen, and not by a compress. A most intense degree of cold is produced by dropping ether on the part, and effecting rapid evaporation by blowing. Evaporating lotions are applied to the head with great relief in cephalalgia, phrenitis, fever with disorder of the cerebral faculties, and poisoning by opium. In the treatment of traumatic ophthalmia, as well as of the incipient stage of inflammation of the outer tunics of the eye, cold lotions are useful; but in internal ophthalmia they are injurious.

3. COLD BY CONDUCTION.

Cold substances placed in contact with the body cool it by conducting away its heat. Those which are employed for this purpose are *cold air*, *cold liquids*, and *cold solids*.

a. *Cold Air.*

In febrile diseases, accompanied with preternatural heat, exposure to pure and moderately cool air (from 50° to 60° F.) lowers the temperature of the body, and reduces excessive vascular action.

b. *Cold Liquids.*

α. Cold Liquids used externally.

1. THE COLD BATH.—The temperature of this ranges from 33° to about

75° F.: when below 50° F., the bath is considered very cold. Its primary effects constitute the *shock*,—its secondary effects, the *reaction* or *glow*.

The immediate effects of the cold bath are—a sensation of cold (speedily followed by one of warmth), contraction of the cutaneous vessels, paleness of the skin, diminution of perspiration, and reduction of the volume of the body. Shivering, and, as the water rises to the chest, a kind of convulsive sobbing, are also experienced. Continued immersion renders the pulse small, and, ultimately, imperceptible, and the respiration difficult and irregular; a feeling of inactivity succeeds; the joints become rigid and inflexible; pain in the head, drowsiness, and cramps, come on; the temperature of the body falls rapidly; and faintness, followed by death, ensues.

The contracted state of the superficial vessels produced by the cold and by the pressure of the water causes the blood to accumulate in the internal vessels. The palpitations arise from the efforts made by the heart to rid itself of the increased quantity of blood thrown on it; while the pulse continues small, because the arteries remain contracted. The internal veins becoming gorged, the functions of the brain necessarily suffer; and hence arise headache, drowsiness, cramps, and, in some cases, apoplexy. The difficult respiration depends on the accumulation of blood in the lungs. The contracted state of the superficial vessels accounts for the diminished perspiration; while the increased secretion of urine is referable to the blood being driven towards the internal organs.

If the immersion be only temporary, reaction quickly follows. The cutaneous circulation is speedily re-established; a glow is felt; perspiration comes on; the pulse becomes full and frequent; and the body feels invigorated.

The cold bath is employed with the view of obtaining the nervous impression or shock,—the refrigeration,—or the reaction or glow[1]; but principally for the latter purpose in cases where it is desirable to increase the tone and vigour of the body.

In weakly and debilitated subjects, the reaction or glow is imperfectly effected, and in such the cold bath acts injuriously. In delicate persons (females especially), with feeble and languid circulation, cold extremities, and torpor of system, cold sea-bathing frequently aggravates all these symptoms[2]. Whenever cold bathing is followed, for several hours, by coldness of surface, blueness of lips, feeble pulse, reduction of strength, and headache, its use should be prohibited.

In diseases of the heart and lungs it is a dangerous remedy; as also in persons disposed to apoplexy, and who are unaccustomed to cold bathing. It is a common opinion that immersion in cold water is dangerous when the body is heated by exercise, or other exertion; and hence it is customary with bathers to wait until they become cool. Dr. Currie[3] has strongly combated both the opinion and the practice: the first, he says, is erroneous; the second, injurious.

The Cool Bath (whose temperature is from 60° to about 75°) is commonly used as a luxury, and for cleanliness.

2. COLD AFFUSION (*perfusio*; καтάχυσις).—Affusion was employed as a hygienic agent and luxury, by the Greeks and Orientals at a very early

---

[1] *Cyclopædia of Practical Medicine*, art. *Bathing*, by Dr. J. Forbes.

[2] For some judicious remarks on this subject, consult Dr. Metcalfe's work entitled *Caloric; its Mechanical, Chemical, and Vital Agencies in the Phenomena of Nature*, 2 vols. 8vo. Lond. 1843.

[3] *Medical Reports on the Effects of Water, cold and warm, as a Remedy in Fever and other Diseases*, vol. i. p. 112.

period. Homer[1] makes some allusions to it; Hippocrates[2] used it in medicine; and Celsus[3] recommends it in some affections of the head. The last-mentioned writer also states, that Cleophantus (a physician who lived about 300 years before Christ) employed hot affusion in intermittents.[4]

The affusion on the head is thus effected:—The water is to be poured on the head (inclined over a pan or tub), by means of an ewer or pitcher, from a height of two or three feet. If the patient be confined to his couch, the head should be inclined over the side of the bed. In children, it is sufficient to squeeze a large sponge (previously soaked in water) at some height above the head, as recommended by Dr. Copland.[5] When the object is to apply affusion to the whole body, the patient is placed in a large tub or pan (*e.g.* a bathing tub or washing pan), and then an attendant, standing on a chair, may readily effect it. The time that the affusion should be continued varies, according to circumstances, from a quarter of a minute to two or three minutes; but in some cases it has been employed for twenty minutes. After the affusion the body should be carefully wiped dry, the patient wrapped up warm, and placed in bed.

The effects of affusion depend partly on the temperature of the liquid, and partly also on the sudden and violent shock given to the system by the mechanical impulse: hence the reason why the effects vary according to the height from which the water is poured.

When water whose temperature is between 32° and 60° F. is used, we denominate the affusion *cold*. To a certain extent the effect of cold affusion is analogous to that of the cold bath, but modified by two circumstances, namely, the short period during which the cold is applied, and the mechanical influence of the stream: hence, its primary effects are very transient, and reaction speedily follows. By a long continuance of affusion, however, the heat of the body is considerably reduced, and the same diminution of vital action occurs as when the cold bath is employed. "When," says Dr. Copland, "the stream of water is considerable, and falls from some height upon the head, the effect on the nervous system is often very remarkable, and approaches more nearly than any other phenomenon with which I am acquainted to electro-motive or galvanic agency."

Cold affusion is used principally in those cases where it is considered desirable to make a powerful and sudden impression on the system; as in continued, intermittent, and eruptive fevers. In *fever* it may be used with safety, according to Dr. Currie[6] and others, "when there is no sense of chilliness present, when the heat of the surface is steadily above what is natural, and when there is no general or profuse perspiration." It is inadmissible during either the cold or the sweating stage of fever, as also in the hot stage, when the heat is not greater than ordinary. In some instances it seems to act by the shock it communicates to the system; for the effect is almost immediate, the disease being at once cut short. The patient has fallen asleep immediately afterwards, profuse perspiration has succeeded, and from that time recovery commenced. This plan of extinguishing a fever, however, frequently fails; and, in that event, it may place the patient in a worse condition than before; hence it is not often adopted.

---

[1] *Odyssey*, x. 362.

[2] *Aphorismi*, sect. v. aph. 21; and sect. vii. aph. 42.

[3] Lib. i. cap. 4.

[4] *Ibid.* lib. iii. cap. 14.

[5] *London Medical Gazette*, vol. x.

[6] *Op. supra cit.*

In *eruptive fevers* it has been applied during the fever which precedes the eruption, as also after this has been established; it has been used in both scarlet fever and small-pox, and even in measles; but its employment in the latter disease is objectionable, on account of the tendency to pulmonary inflammation, in which affection cold affusion is prejudicial.

Cold affusion has been used in *croup*, principally with the view of removing the spasm of the glottis, which endangers the life of the patient.

Cold affusion is used with advantage in numerous other diseases: as in *poisoning* by hydrocyanic acid, alcohol, opium, belladonna, &c.; in *asphyxia* caused by the inhalation of carbonic acid, the fumes of burning charcoal, sulphuretted hydrogen, &c.; in *hysteria* and *epilepsy*; in *puerperal convulsions*; in *mania*; as also in *tetanus*. In *malignant cholera* it sometimes proved valuable;[1] principally, however, in mild cases. In severe attacks the power of reaction was insufficient. In the latter stages of inflammatory and other *brain affections* of children it is often serviceable.

Cool and tepid affusion are employed as substitutes for cold affusion where dread is entertained of the effect of the latter. They are safer, though less powerful agents.

3. THE SHOWER-BATH (*impluvium*).—The shower-bath is very similar in its effects to, but milder than affusion, and is frequently employed as a hygienic agent to promote the tone and vigour of the body. In insanity it is used with the greatest benefit to allay mental excitement. In violent cases, "the application of the shower-bath, the patient being up to the middle in warm water, seldom fails to subdue the paroxysms."[2] The period during which it should be continued is a circumstance of some moment. Dr. Conolly observes that it "should be suspended when the patient appears overcome, and instantly renewed when symptoms of violence recur. A strong shower continued even for a minute has sometimes considerable effect;" and it should never be "many minutes prolonged without careful observation of the patient's state. After four or five applications of this kind, the patient becomes entirely subdued, and should then be taken out of the bath, rapidly dried, warmly covered up, and put into bed, with every possible demonstration of kind attention. Calmness and sleep are the usual results; and more permanent effects frequently follow. A bath of this kind appears to produce a moral as well as a physical impression; being succeeded, in recent cases, by tranquillity for a few days, and in chronic cases by quietness and improved behaviour for many weeks, and sometimes even for months."

An extemporaneous shower-bath, produced by the aid of a cullender, may be used to allay the violent delirium of fever; and is rendered more beneficial if the patient can be persuaded to sit in a semicupium of warm water.[3]

4. THE DOUCHE (*duccia*).—The term *douche* is applied to a stream of water directed to, or made to fall on, some part of the body. Its effect depends in part on the mechanical action or percussion, and in part on the

---

[1] *Lond. Med. Gaz.* vol. ix. pp. 452, 502, and 505.
[2] Dr. Conolly's *Report*, before quoted, p. 66.
[3] Dr. Lendrick, *Lond. Med. Gaz.* vol. xxiv. p. 104.

temperature, of the liquid. A column of water twelve feet high, made to fall perpendicularly on the top of the head, excites such a painful sensation, that, it is said, the most furious maniacs, who have once tried it, may sometimes be awed merely by the threat of its application; and hence one of its uses in madness, as a means of controlling the unfortunate patient. "A controversy lately arose among certain French physicians concerning the application of the douche; which some were disposed to use as a specific against delusive notions. The patient was to be kept under the douche until he entirely recanted. The principle is extremely doubtful, and it should be remembered of every severe application, that lunatics are seldom able to make their real sufferings distinctly known. M. Esquirol subjected himself to the douche; and he describes the sensation as very painful, resembling the continued breaking of a column of ice on the head, followed by a feeling of stupefaction which lasted an hour afterwards."[1]

The douche is one of the remedies employed by hydropathists.

It is a powerful and dangerous stimulant, and requires great caution in its use and application.

Topical douches are applicable in some cases of local disease requiring a powerful stimulus; as old chronic affections of the joints, whether rheumatic, gouty, or otherwise;[2] paralytic affections; sciatica; old glandular swellings; chronic headache; deafness, &c. Dr. Butzke[3] has recently employed it with good effect in old ulcers of the feet.

The eye-douche has been employed as a hygienic agent. Jungken regards it as an effective stimulant for promoting the restoration of convalescent eyes, and which may be substituted for eye-waters and spirit-washes. Beer contrived an apparatus for effecting it. It consisted of a double tin vessel; the outer vessel containing ice, to cool the water contained in the inner one. From the inner vessel descended a narrow tin tube of about four or five feet long, and terminating in a fine jet turned upwards, from which, when required, could be obtained a slender stream of water, which was regulated by a stopcock. Schmalz, Mauthner, and Bischoff, have effected various modifications of this apparatus. The simplest method consists of a tumbler filled with ice-cold water, into which dips the short leg of a glass syphon. The longer leg of the syphon should descend considerably below the bottom of the tumbler, and terminate in a small point curved upwards. Gräfe employed adaptation tubes of glass or brass, which were attached to the syphon by an india-rubber collar, and by means of which every requisite direction and force could be given to the jet of water.

The operation of *pumping* practised at Bath may be regarded as a kind of douche. The degree or extent of the application is determined by the number of times the handle of the pump is raised or depressed. From 20 to 200 strokes of the pump is the number generally directed to be taken at one time, which, however, may be increased or diminished according to the age, sex, strength, or other circumstances of the patient.[4] The water does not issue in gushes, but in a continuous stream.

---

[1] Dr. Conolly's *Report*, before cited, p. 68.

[2] See some observations of Lisfranc on the use of the douche in white swelling, in the *Lancet* for 1834-35, vol. ii. p. 337.

[3] *London Medical Gazette* for 1839-40, vol. i. p. 893.

[4] *A Practical Dissertation on the Medicinal Effects of the Bath Waters*, by W. Falconer, M.D. 1790.

5. WASHES.—Cold, cool, or tepid washing or sponging may be used in febrile diseases, with great advantage, in many cases where affusion is not admissible, or where timidity on the part of the patient or practitioner prevents the employment of the latter. Dr. Currie[1] remarks, that in all cases of fever where the burning heat of the palms of the hands and soles of the feet is present, this method of cooling them should be resorted to. A little vinegar is frequently mixed with the water, to make the effect more refreshing. Cold washing is also used to lessen the susceptibility of the skin, and diminish the liability to rheumatism and catarrh. On the same principle it is employed to check nocturnal emissions. Washing or sponging must be effected under precisely the same regulations as those already laid down for affusion.

Dr. Kinglake[2] recommended the application of cold water to parts affected with gout; but the practice is somewhat hazardous. One method of treating burns is by the application of cold water to the injured part. In modern times, Sir James Earle[3] was the great advocate for this plan, which proves more successful in scalds and slight burns. The burnt part should be covered with rags, and kept constantly wetted with water, in which ice is placed from time to time; "care being taken never to remove the rags from the burnt surface."[4]

If the cold fluid be continually renewed, the practice has been called *irrigation*.[5] It is effected either by allowing cold water to drop on the affected part, from a stopcock inserted in the side of a bucket of water, or by conducting a stream of water from a vessel by means of a strip of cloth, on the principle of a syphon.

β. Cold Liquids used internally.

1. COLD DRINKS. — Hippocrates,[6] Celsus,[7] and other ancient writers, employed cold water as a drink in ardent fever. In modern times, also, it has been extensively used in the same malady. Dr. Hancocke[8] called it the *febrifugum magnum*. Its employment, however, has not been limited to fever. From its supposed great efficacy in gouty complaints, Heyden[9] termed it the *arthritifugum magnum*.

We are indebted to Dr. Currie for the examination of the circumstances under which the internal employment of cold water in fever is proper. According to him, it is inadmissible during the cold or sweating stage, but is both safe and advantageous when the skin is dry and burning: in other words, the regulations for it are precisely the same as for cold affusion. When exhibited under proper circumstances, cold water operates as a real refrigerant, reducing preternatural heat, lowering the pulse, and disposing to sweating.

---

[1] *Reports*, 4th edit. vol. i. p. 72.

[2] *A Dissertation on the Gout*, Lond. 1804; *Additional Cases of Gout*, Lond. 1807.

[3] *An Essay on the Means of Lessening the Effects of Fire on the Human Body*, Lond. 1799.

[4] *Two Lectures on the Primary and Secondary Treatment of Burns*, by H. Earle, Lond. 1832.

[5] Macartney, *Treatise on Inflammation*, p. 158, Lond. 1838.

[6] *De Usu Liquidorum*.

[7] Lib. iii. cap. 7.

[8] *Febrifugum Magnum, or Common Water the best Cure for Fevers, and probably for the Plague*, 5th edit. Lond. 1723.

[9] *Arthritifugum Magnum, a Physical Discourse on the Wonderful Virtues of Cold Water*, Lond. 1724.

Occasionally, however, serious and even fatal consequences have resulted from the employment of large quantities of it by persons who have been rendered warm by exercise or fatigue.

Besides fever, there are several other affections in which cold water is a useful remedy. For example: to facilitate recovery from epilepsy, hysteria, and fainting; and to alleviate gastric pain and spasm. Large draughts of it have sometimes caused the expulsion of intestinal worms (*Tænia* and *Ascaris vermicularis*).

2. COLD INJECTIONS.—*a.* Cold water is thrown into the *rectum* to check hemorrhage, to expel worms, to allay local pain, to rouse the patient in poisoning by opium, to relieve the pain of hemorrhoids, and to diminish vascular action in enteritis.

b. Dr. A. T. Thomson[1] speaks very favourably of the effects of cold water introduced into the *vagina*, by means of the stomach-pump, in uterine hemorrhage.

The COLD-WATER CURE, or hydropathy, though not yet admitted by the medical profession among the legitimate means which may be beneficially employed in the treatment of diseases, undoubtedly includes powerful therapeutic agents, which, in the hands of the educated and honourable practitioner, might be most beneficially resorted to. It does not confine itself to the use of *cold water* only, but includes *dry sweating*, *diet*, *exercise*, and *regulated clothing*. The cold water is employed both internally and externally: *internally* in the form of potions, gargles, lavements, and injections into the ears, urethra, and vagina; *externally* by baths, ablutions, wet linen sheets, and wet compresses. The baths are both general and local: the former include full baths (portable, plunging, river, and wave baths), half-baths, shower-baths, douches (including the sturz-bath, a douche on a large scale), and drop-baths; the local baths comprehend the sitz-bath (sitting bath) either in still or flowing water, the foot-bath, the hand-bath, the head-bath, the ear-bath, the eye-bath, &c.—I must refer the reader who may be desirous of information respecting it to works professedly devoted to this subject.

c. *Cold Solids: Ice and Snow.*

The temperature of these agents does not exceed 32° F. They are employed both internally and externally, to obtain sometimes the primary, at other times the secondary effects of cold.

1. EXTERNAL USE.—*a. Of the Primary Effects.*—Ice is used to check hemorrhage, more especially when the bleeding vessel cannot be easily got at and tied; as after operations about the rectum, more especially for piles and fistula. It is applied to the chest in dangerous hemoptysis, and to the abdomen in violent floodings. In some of these cases, especially in uterine hemorrhage, more benefit is obtained by pouring cold water from a height (*cold affusion* or *douche*) than by the use of ice.

A bladder containing pounded ice (*ice poultice*) has been applied to hernial tumours to diminish their size and facilitate their reduction; but notwithstanding that the practice has the sanction and recommendation of Sir Astley Cooper,[2] it is, I believe, rarely followed, not having been found successful: while, if too long continued, it may cause gangrene. In this, as well as in other cases, where ice or snow cannot be procured, a *freezing mixture* may be substituted. For this purpose, five ounces of sal ammoniac, five ounces of nitre, and a pint of water, are to be placed in a bladder, and applied to the part. Ice has also been applied in prolapsus of the rectum or vagina, when inflammation has come on which threatens to terminate in mortification.

---

[1] *Elements of Materia Medica and Therapeutics*, vol. ii. p. 78, Lond. 1833.

[2] *The Anatomy and Surgical Treatment of Inguinal and Congenital Hernia*, p. 35, Lond. 1804.

The *ice-cap* (*i. e.* a bladder containing pounded ice) is applied to the head with great benefit in inflammation of the brain; in fever, where there is great cerebral excitement, with a hot dry skin; and in acute hydrocephalus. In apoplexy, likewise, it might be useful; as also in delirium tremens, and in mania with great mental excitement. In the retention of urine to which old persons are liable, ice-cold water applied to the hypogastrium is sometimes very effective in causing the evacuation of this secretion.

b. Of the Secondary Effects.—Friction with ice or snow is employed to produce the secondary effects of cold in diminished sensibility of the skin, and in the rheumatism or gout of old and enfeebled persons; but its most common use is as an application to frost-bitten parts. The feet, hands, tip of the nose, and pinnæ of the ears, are the organs most frequently attacked. In order to guard against mortification, and other ill effects arising from a too rapid change of temperature, the vital properties must be slowly and gradually recalled. In order to effect this, the frost-bitten part should be rubbed with snow or pounded ice, or bathed in ice-cold water, very gradually raising the temperature of the applications until the part acquires its natural heat.

2. INTERNAL USE.—Ice, or ice-cold water, is swallowed for the purpose of obtaining either the primary or the secondary effects of cold. Thus, it is taken to cause contraction of the gastric vessels, and thereby to check or stop hemorrhage from the mucous membrane of the stomach. It has also been found beneficial in nasal, bronchial, and uterine hemorrhage. In the latter cases, the constriction of the bleeding vessels must be effected through the sympathetic relations which exist between the stomach and other organs. Ice is also employed to relieve cardialgia, vomiting, and spasmodic pain of the stomach. In the latter stage of typhus fever its internal use is sometimes beneficial.

4. ELECTRICITAS.—ELECTRICITY.

GENERAL REMARKS.—The agent or force denominated electricity (from *ἤλεκτρον, amber*) appears to exist in all terrestrial bodies, either in a *passive* and *quiescent* condition, or in an *active* and *free* one. The latter state may be induced by a variety of circumstances, which are denominated *modes of electrical excitement*, or *sources of electricity*; and the bodies in which this condition of electrical activity is made manifest are said to be *electrified*.

Active or *free electricity* exists either in a state of rest and equilibrium, when it is called *statical*, or in that of motion or progressive motion, when it is termed *dynamical*. Its activity is manifested by the production of various phenomena, denominated its *effects*, and which are of six kinds; namely, *mechanical, luminous, calorific, chemical, magnetic*, and *physiological*.

The phenomena presented by electricity, obtained from different sources, differ "not in their character, but only in degree; and, in that respect, vary in proportion to the variable circumstances of *quantity* and *intensity*[1]."

---

[1] *Experimental Researches in Electricity*, by M. Faraday, Lond. 1839, 8vo. p. 102; and *Philosophical Transactions*, 1833.

"The term *quantity*, in electricity," says Dr. Faraday, "is, perhaps, sufficiently definite as to sense; the term *intensity* is more difficult to define strictly." It is commonly used to indicate the ability or power which electricity possesses of overcoming resistance to its progress, and which varies in degree in different cases.

The voltaic battery yields a large quantity of electricity of low intensity, and which possesses great chemical and but little attractive and repulsive powers; whereas the common electrical machine gives a small quantity of electricity of high intensity, and whose chemical powers are very feeble, but whose attractive and repulsive influence is very great. The former source, therefore, is said to yield *electricity of quantity;* the latter, *electricity of intensity.*

The relative *quantities* of electricity evolved by the ordinary electrical machine and the voltaic battery have been ascertained by Dr. Faraday[1] to be as follows.—A voltaic battery, consisting of "two wires, one of platina and one of zinc, each one eighteenth of an inch in diameter, placed five-sixteenths of an inch apart, and immersed to the depth of five-eighths of an inch in acid, consisting of one drop of oil of vitriol and four ounces of distilled water at about 60° Fah., and connected at the other extremities by a copper wire eighteen feet long, and one-eighteenth of an inch in thickness, yielded as much electricity, in little more than three seconds of time, as a Leyden battery charged by thirty turns of a very large and powerful plate machine [fifty inches in diameter] in full action." And the same authority further observes, that 800,000 such charges of this Leyden battery "would be necessary to supply electricity sufficient to decompose a single grain of water."

The relative degrees of *intensity* of the electricity obtained from the common electric machine and from the voltaic battery have not been accurately measured. The following illustrations, however, will give some idea of their enormous difference:—"When in good excitation," says Dr. Faraday,[2] "one revolution of the plate [machine above alluded to] will give ten or twelve sparks from the conductors, each an inch in length. Sparks or flashes, from ten to fourteen inches in length, may be easily drawn from the conductors." It is obvious, therefore, that the intensity of the electricity thus obtained is very great. But that of voltaic electricity, though varying according to the chemical character of the elements used and the energy or intensity of the affinities,[3] is always much more feeble. Mr. Gassiot[4] found that the electricity produced by 320 series of Daniell's constant battery affected the gold-leaf electrometer, but did not possess sufficient intensity to pass through $\frac{1}{5000}$th of an inch of air. With a water battery of 3520 pairs, the sparks were only $\frac{1}{50}$th of an inch long.[5] Lastly, with 100 series of Grove's nitric acid battery, carefully insulated, the terminals consisting of copper disks six inches in diameter, the sparks obtained were only $\frac{1}{1000}$th of an inch in length.[6]

The action or effect called the *discharge* may be effected in four modes:[7] by conduction, by convection, by disruption, and by electrolysis.

The discharge of electricity through the animal body, like that through water and acidulated and saline solutions, is effected by electrolysis.

In the electrolytic discharge, the *ions*, or substances which are evolved or set free by the electro-chemical decomposition, appear only at the electrodes or poles, these being "the limiting surfaces of the decomposing substance, and, except at them, every particle finds other particles, having a contrary tendency, with which it can combine."[8]

In every mode of effecting electrical excitement there are two opposite or antagonist electricities set free: the one, called *positive* or *vitreous*; the other, *negative* or *resinous*.

---

[1] *Experimental Researches in Electricity*, pp. 102–7, and pp 252–53.

[2] *Op. cit.* p. 84.

[3] Faraday, *Phil. Trans.* 1834, 9th Series of Researches, § 905–909.

[4] *Phil. Trans.* 1840.

[5] *Ibid.* 1844.

[6] Meeting of the British Association, 1846.

[7] Faraday, *Phil. Trans.* 1838, 12th Series of Researches.

[8] Faraday, *Phil. Trans.* 1833, 5th Series of Researches, § 535.

The physical and chemical phenomena produced by an electric discharge vary somewhat according as it takes place from a positive or negative surface.[1] The physiological effects appear to be the same; though formerly positive electricity was supposed to be stimulant, while negative electricity was thought to be sedative.[2]

PHYSIOLOGICAL EFFECTS.—*a. On Vegetables.*—No conclusive evidence has hitherto been adduced demonstrative of the influence of electricity in promoting vegetation.[3]

b. On Man and other Animals.—Electricity is distinguished from other physical agents by its faculty of affecting all our senses; whereas "light excites no organs but those of vision. Heat acts only on our feeling; whilst magnetism exerts upon our frames no perceptible influence whatever."[4]

It will be convenient to consider the effects first of statical, and afterwards of dynamical, electricity.

1. *Effects of Statical Electricity on Man and other Animals.*—No perceptible influence is exercised by statical electricity over the animal functions. In clear and serene states of the weather, the atmosphere is usually charged with positive electricity, which, by induction, renders the surface of the earth, and all living beings thereon, negative; while, in damp and wet weather, the reverse states usually exist; the atmosphere being negative, and the surface of the earth positive. We are unable, however, by our feelings to detect these opposite electrical conditions of the atmosphere, or to ascribe to them any peculiar influence on the system.

When we place a patient in what is called the *electric bath*, that is, on the insulating stool or chair, and in connection with the prime conductor of a common electrical machine, the whole surface of the body becomes charged with positive electricity, while the atmosphere surrounding it is rendered negative; but no constant and certain physiological effect is observed therefrom. In some cases, it is said the pulse is quickened; in others, unaltered; while, in a third class of cases, it becomes reduced in frequency at the end of ten or fifteen minutes.[5] But these phenomena, as well as the copious perspiration, which has also been ascribed to the electric bath, are referable rather to the excited imagination, fear, or other feelings of the patient, than to the direct influence of electricity on the body.

2. *Effects of Dynamical Electricity on Man and other Animals.*—The progressive action or motion of electricity, usually denominated the *electric current*, produces remarkable and powerful effects on the animal system: these we may conveniently arrange under four heads; viz. effects on the nervous system, effects on the muscles, effects on the secretory organs, and effects on the heart and blood-vessels.

---

[1] *Phil. Trans.* 1838, 12th and 13th Series of Researches; Walker, *Account of Experiments with a Constant Battery*, in the *Transactions of the London Electrical Society*, 1838.

[2] Apjohn, in *Cyclopædia of Practical Medicine*, vol. i. art. *Electricity*.

[3] See an interesting paper by Mr. Edward Solly, *On the Influence of Electricity on Vegetables*, in the *Journal of the Horticultural Society*, vol. i. 1845. Also, *Further Observations*, in the same Journal, 1847.

[4] Peschel's *Elements of Physics*, vol. ii. p. 1, 1846.

[5] See Mr. Smith's experiments, in Dr. Hodgkin's Translation of Edwards' work, *On the Influence of Physical Agents on Life*, p. 335, Lond. 1832.

a. Effects on the Nervous System.—According to Matteucci,[1] the nerves are somewhat better conductors of electricity than the cerebral substance; but their conducting power is four times less than that of muscle. Todd and Bowman,[2] however, could detect no appreciable difference in the conducting power of nerve and muscle.

But the nerves do not appear to be equally good conductors in all directions; at least, it appeared to Matteucci that the spinal nerves were better conductors in the centrifugal than in the centripetal direction.[3]

αα. On the Nerves of Sensation.—The electric current acts like other stimulants on the nerves of sensation, and excites the special function of each nerve. Thus, when transmitted along the *nerves of touch*, it excites pain, the shock, and other disagreeable sensations; along the *optic nerve*, it causes the sensation of light; along the *gustatory nerve*, a remarkable taste; along the *auditory nerve*, sound;[4] and along the *olfactory nerve*, the sensation of smell.[5]

The effect on the gustatory nerve is not referable to the action of the substances produced by the electrolysis of the salts of the saliva; for, *firstly*, the sensation may be excited by a current which is too feeble to decompose these salts; and, *secondly*, Volta experienced an acid taste from the influence of an electric current at the moment when his tongue was in contact with an alkaline solution.

ββ. On the Nerves of Motion.—When an electric current is transmitted along a nerve of motion, contraction of the muscles to which the nerve is distributed is produced.

MM. Longet and Matteucci[6] have made some very curious observations on the effects of the electric current on motor nerves. Immediately after the death of the animal, muscular contractions are induced both at the commencement and at the interruption or cessation of the current, whether it be direct or inverse. But some time after, or in what is called the second stage of the vitality of the nerve, the muscles are thrown into contraction only at the commencement of an inverse or centripetal current, and at the cessation of a direct or centrifugal current.

A current is said to be *direct* or *centrifugal* if it pass in the direction from the brain towards the distal extremities of the nerves. An *inverse* or *centripetal* current is one that passes in the opposite direction.

The susceptibility of motor nerves to the influence of the electric current may be destroyed by the action of narcotic poisons; by a sufficiently prolonged separation of the nerves from the central parts of the nervous system; by a ligature interposed between the parts of the nerve irritated and the muscles; and by continued excitation of the nerve.[7] But the muscular contractions caused by the commencement of the inverse current continue to be produced for a much longer time than those which arise from the cessation of the direct current.

---

[1] *Traité des Phénomènes Electro-Physiologiques des Animaux*, p. 48, Paris, 1844.

[2] *Physiological Anatomy*, p. 243, 1845.

[3] *Traité*, p. 50.

[4] Volta, *Phil. Trans.* for 1800, p. 403.

[5] Müller's *Elements of Physiology*, by Baly, vol. i. p. 623, Lond. 1838.

[6] *Rapport entre le sens du Courant électrique et les Contractions musculaires dues à ce Courant*, (*Comptes rendus de l'Académie des Sciences du* 9 Sept. 1844).

[7] Matteucci, *Traité*, p. 214.

77. On Mixed Nerves.—By mixed nerves are meant, nerves which have a double root, and which, therefore, are both sensitive and motor. A current of electricity transmitted along a mixed nerve excites both sensation and muscular contraction.

MM. Longet and Matteucci[2] have observed a very remarkable difference in the effect of the electric current on the motor and mixed nerves. In the second stage of the vitality of the mixed nerves, the direct or centrifugal current excites contractions only at its commencement; while the inverse or centripetal current excites them only at its cessation. These phenomena are directly the reverse of those which occur in the case of the motor nerves before noticed.

In the following table the different effects of centripetal and centrifugal currents are contrasted:—

EFFECTS OF ELECTRIC CURRENTS ON MOTOR AND MIXED NERVES.

NERVES.	EFFECTS OF CURRENTS.					
	Direct or Centrifugal Current.			*Inverse or Centripetal Current.*		
	Commencement.	Closed Circuit.	Cessation.	Commencement.	Closed Circuit.	Cessation.
1st *Period of Vitality.*						
Motor nerves	Muscular contractions.	No effect.	Muscular contractions.	Muscular contractions.	No effect.	Muscular contractions.
Mixed nerves	Strong contractions of superior and inferior muscles,[3] and pain.	No effect.	Contraction of superior and inferior muscles, and pain.	Contraction of superior and inferior muscles, and great pain.	No effect.	Contractions of superior and inferior muscles, and pain.
2d *Period of Vitality.*						
Motor nerves	No effect......	No effect.	Muscular contractions.	Muscular contractions excitable for a longer period.	No effect.	No effect.
Mixed nerves	Contractions of the inferior muscles.	No effect.	Contractions of superior muscles, and pain.	Contractions of superior muscles, and pain.	No effect.	Contraction of inferior muscles.

22. On the Ganglionic or Sympathetic Nerves.—The ganglionic or sympathetic nerves are sensitive, and possess a motor though involuntary influence over the parts they supply: hence, therefore, a current of electricity transmitted along these nerves should, in conformity with its influence on the mixed nerves above noticed, excite both sensation and muscular contraction. Matteucci[3] confirms the statement of Humboldt and Müller,[4] that the electric

---

[1] Longet and Matteucci, *Rapport.*

[2] The terms *superior* and *inferior* refer to the point of excitation. The superior muscles are those supplied from nerves which come off above the point of excitation; the inferior muscles, on the contrary, are those supplied from nerves which come off below the point of excitation. Contractions of the superior muscles are *reflected movements*, and are due to the irritation of the nervous centre affected through the sensitive nerves.

[3] *Traité*, p. 247.

[4] Müller's *Physiology*, by Baly, vol. i. pp. 191 and 663.

current applied to the cardiac and splanchnic nerves excited respectively contractions of the heart and the peristaltic movements of the intestines; but I am unacquainted with any experiments in which sensation was excited by the influence of electricity on the ganglionic nerves.

Matteucci has observed some remarkable peculiarities in the action of the current on the ganglionic nerves. Instead of commencing immediately on the closure of the circuit, the contractions did not appear until some time subsequently, and they continued after the current had ceased. In these respects, however, electricity agrees with other stimulants in its action on these nerves. Matteucci was unable to recognise any well-marked difference between the effects, on the ganglionic nerves, of the direct or centrifugal current and those of the inverse or centripetal one.

The influence, on the secreting organs, of the electric current transmitted along the ganglionic nerves is an interesting object of inquiry, and one which requires examination. Krimer[1] states that, by division of the sympathetic nerve in the neck, the urine was rendered alkaline and albuminous; but, on the application of galvanism, its normal properties were restored.

εε. On the Nervous Centres.—Instantaneous death is produced by the passage of powerful charges of electricity through the brain. Rabbits and other small animals may be thus destroyed by the discharge from the electrical battery, or even from a large Leyden jar; and the death produced by lightning is a further illustration of the instantaneous and fatal effects of electricity on the nervous system.

When the charge is not sufficiently powerful to cause immediate death, the effects produced are analogous to those of concussion of the brain.[2]

Mr. Singer[3] "once accidentally received a considerable charge from a battery through the head; the sensation was that of a violent but universal blow, followed by a transient loss of memory and indistinctness of vision, but no permanent injury ensued." The same authority observes that, if "the charge is passed through the spine, it produces a degree of incapacity in the lower extremities; so that if a person be standing at the time, he sometimes drops on his knees, or falls prostrate on the floor."

Some interesting experiments have been made by Matteucci,[4] both alone and in conjunction with Longet,[5] on the effects of the voltaic current on the nervous centres of animals. Neither muscular contractions nor apparent pain were produced when the current was transmitted through the cerebral hemispheres, or through the cerebellum, or through the pulp of the hemispheres either of the cerebrum or cerebellum. Neither were any contractions produced by the passage of the current through either the posterior columns or grey substance of the spinal cord. But both pain and muscular contractions were induced when the current acted on the corpora quadrigemina and crura cerebri; and the effect of both the direct and the inverse current on the anterior columns of the cord were the same as those produced on the motor nerves; that is, contractions were excited under the same circumstances. We may conclude, therefore, says Matteucci, that the electric current acts on the central parts of the nervous system like other stimulants whose action has been so well determined by M. Flourens.

2. *Effects on the Muscles.*—It has been ascertained by Matteucci, that a

---

[1] *Müller's Physiology*, by Baly, p. 470.

[2] *Lond. Med. Gazette*, xiv. 654.

[3] Singer, *Elements of Electricity*, p. 295, Lond. 1814.

[4] *Traité*, p. 242.

[5] *Rapport.*

current of electricity causes the contraction of a muscle from which all visible nerves have been carefully removed; and that the contractions occur both at the commencement and cessation of the current, and are independent of its direction; and he infers from his experiments—

1st. That the property of contracting possessed by the living muscular fibre is inherent.

2dly. That the motor nerves, when irritated, produce contractions in the muscles to which they are distributed by acting on this inherent property of the muscle.

3rdly. That the nerves may be temporarily deprived of this property by circumstances which I have before stated.

4thly. That the muscular fibre requires, for the continuance of its irritability, the simultaneous action of sensitive and organic nerves, and of blood, by which its nutrition is kept up.

When a current of electricity traverses simultaneously muscles and nerves, the contractions which ensue are principally due to the action of the current on the nerve: for, when the current is direct, the contractions occur at its commencement; whereas, when it is inverse, they occur at its cessation.[1]

3. *Effects on the Secreting Organs.*—Although little is known with respect to the precise agency of the nerves in the act of secretion, yet we have abundant evidence to prove that they exercise some influence on this process; and, as the electric current excites the motor and sensitive nerves, it appears, *à priori*, probable that it may also excite the nerves distributed to the secreting organs. "The experiment instituted by the Baron A. von Humboldt on his own person is well known. Having applied two blisters to the region of the shoulders, he covered one of the blistered surfaces with a silver plate, and closed the circle by means of a conductor of zinc, when a painful burning was produced, and a change in the character of the discharge; from being bland and colourless, it became a red acrid fluid, which left livid red streaks on the parts of the back where it ran. M. Most likewise states that, having caused a galvanic current to pass through the parotid, by applying the positive pole to the situation of the gland for the space of ten minutes while he held the negative pole in his hand, an increased secretion of saliva, which was neither acid nor alkaline, took place."[2] Furthermore, Krimer reports that the division of the sympathetic nerve in the neck caused the urine to become alkaline and albuminous; but that the application of galvanism restored its normal properties.[3]

Dr. Wilson Philip[4] divided the nervi vagi in a rabbit, and found, as he supposed, that the digestive process was stopped; and in another experiment he restored, as he tells us, the functions of these nerves by the voltaic influence. But subsequent experiments have shown that the division of the nervi vagi does not wholly stop the digestive process, and that electricity cannot restore it to its original state.[4]

4. *Effects on the Heart and Blood-vessels.*—I have already stated that contractions of the heart may be induced by galvanizing the cardiac nerves.

---

[1] For information with respect to the important subject of animal electricity, the reader is referred to the Lectures on the Physical Phenomena of Living Beings, by Carlo Matteucci, translated under the superintendence of the late Dr. Pereira (*Longman & Co.*), and also to a work edited by Dr. Bence Jones, containing an abstract of the Discoveries of Emil du Bois-Raymond (*Churchill*).

[2] Müller's *Physiology*, by Baly, vol. i. p. 469.

[3] *Ibid.*

[4] *An Experimental Inquiry into the Laws of the Vital Functions*, pp. 111, 213, 256, &c. 3d edit. Lond. 1826.

[5] Müller, *op. ante cit.* p. 549.

But in neither the arteries nor capillaries can contractions be induced by the voltaic current, though Wedemeyer states he has seen a distinct permanent contraction of the small arteries induced by it.[1]

CIRCUMSTANCES MODIFYING THE EFFECTS OF THE ELECTRIC CURRENT.—The physiological influence or effects of the current are modified by the following circumstances:—

1. The intensity of the current.
2. The quantity of electricity passing in the current.
3. The direction of the current.
4. The continuance or intermission of the current.
5. The effects of certain diseases or poisons.

1. *The Intensity of the Current.*—The physiological effects of the electric current are greatly modified by its intensity; if the latter be heightened, the effects are increased, and *vice versâ.*

α. The current of electricity obtained from a single pair of plates produces, under ordinary circumstances, no sensible effect on the sense of touch; but, if its intensity be augmented by transmitting it through repeated coils of wire, its effects become very perceptible.

β. A small quantity of electricity, whose intensity is high, produces very powerful effects; as the discharge of the common Leyden jar or battery: whereas a large quantity of electricity, whose intensity is low, produces very feeble or scarcely perceptible effects.

The electricity evolved by Faraday's wire voltaic battery, before described, would be without perceptible effect on the sense of touch, on account of its feeble intensity. But an equal quantity of electricity, obtained by the ordinary electric machine, and, therefore, of very high intensity, gave a most violent shock; and "if passed at once through the head of a rat or cat," says Dr. Faraday,[2] was sufficient "to have killed it as by a flash of lightning."

A certain degree of intensity is required to enable the current to overcome the resistance offered by the animal body to its transmission.

2. *Quantity of the Current.*—The influence of quantity is best seen in those cases where the intensity of the current is great. Thus the power or force of a shock produced by the discharge of the Leyden bottle or battery is proportional to the area of the metallic coating, the intensity of the electricity being equal. In other words, a large Leyden bottle gives a more powerful shock than a small one charged to the same intensity.

When the intensity is low, and the resistance to the transmission of the current is consequently great, the influence of quantity is slight. Thus, in a voltaic battery, composed of a few pairs of plates, no difference is perceptible between the effects of large and small plates.

In coil machines, the power of the shock is augmented by using, as conductors, large metallic surfaces instead of mere wire points; or by moistening the animal surface with a saline solution. By these means the resistance is lessened, and the quantity of electricity which is transmitted is increased.

3. *Direction of the Current.*—To Volta is due the credit of having discovered the modification which the continued passage of an electric current along the nerves effects in the action of the current itself, and which has, in

---

[1] Müller, pp. 205 and 228.

[2] *Phil. Trans.* 1834, 7th Series of Researches, § 860.

consequence, been termed the *Voltaic alternatives.* The fact is thus stated by Matteucci:—"The current which is transmitted along a motor nerve of a living or recently-killed animal, and which continues to pass along the nerve during a certain period, modifies the excitability so as to render the nerve insensible to the passage of the current so long as it moves in the same direction; but the excitability of the nerve reappears when the current is made to pass in the opposite direction: so that when a nerve has been modified by the passage of the current in the way described, we may restore to it its lost excitability by reversing the current. Thus, at every change in the direction of the current, the limb, which previously contracted only when we closed the curcuit, becomes now capable of contracting at the interruption of the same circuit."

The different effects of the direct or centrifugal, and of the indirect or centripetal, current on the motor and mixed nerves have been already stated.

Matteucci found that the centrifugal current destroyed the excitability of the nerves much more speedily than the centripetal current.

4. *Continuance or Intermission of the Current.*—An intermitting current (*i. e.* a current alternately interrupted and renewed at very short intervals), excites tetanic convulsions; but sooner exhausts the excitability of a nerve than a continuous current.[1]

5. *Effects of certain Diseases and Poisons.*—The effects of electricity are modified by the existence of paralysis. Thus, an electric shock, transmitted through a part affected with paralysis of sensation, produces little or no pain (according as the disease is incomplete or complete); while the effect of a similar shock on a healthy part is very painful. In several cases of hemiplegia, consequent on apoplexy, I have found that the muscular contractions caused by the vibrating current of a coil machine were very feeble in the paralysed limb, while they were very powerful in the healthy one.

Hydrocyanic acid, or a solution of opium, or one of nux vomica, or death by the electric shock, lessens or destroys the excitability of the nerves submitted to the electric current, though the muscles retain their irritability.

Carbonic acid, sulphuretted hydrogen, nitrogen, and *chlorine,* do not possess the power of exhausting the excitability of the nerves.

CHARACTER AND PECULIARITIES OF THE PHYSIOLOGICAL ACTION OF ELECTRICITY ON MAN AND ANIMALS.—Electricity acts on the nervous system of living or recently-killed animals as a stimulant or excitant.

Like heat, alkalies, and mechanical irritation, it excites sensation when applied to the sensitive nerves, and muscular contractions when applied to motor nerves. It further agrees with these stimulant agents in the circumstance that its prolonged action exhausts the nervous excitability; but it differs from other stimulants in several circumstances, of which, according to Matteucci,[2] the following are the principal:—

1. The electric current excites either muscular contraction or sensation according to the direction in which it is transmitted along a mixed nerve.
2. The electric current excites neither contraction nor sensation when passed transversely across a nerve.
3. The electric current produces no effect by its prolonged transmission along a nerve.
4. The electric current excites a nerve when it ceases to pass.

---

[1] Matteucci, *Traité,* p. 232, et seq.

[2] *Ibid.* p. 251.

5. The electric current restores the excitability of a nerve which has been exhausted by a reverse current.
6. The electric current retains for a longer period than any other stimulant its power of rousing the excitability of a nerve.

CORRELATION OF THE ELECTRICAL AND NERVOUS FORCES.—Between electricity and the *vis nervosa* there exist, both in their development and propagation, several striking analogies, which at one time disposed physiologists to regard these two forces as identical; but the failure of the most competent experimentalists to detect electric currents in the nerves, and the well-ascertained differences in properties between electricity and the *vis nervosa*, have led more recent physiologists[1] to reject the electrical hypothesis of nervous power, which, in the present state of our knowledge, seems to me to be no longer tenable.

USES.—Electricity is employed as a therapeutical agent sometimes rationally, sometimes empirically.

When it is resorted to for the purpose of producing one or more of its known physiological effects, and thereby of fulfilling an indication in the treatment of a disease, its use may be termed *rational.*

But it has been employed in some diseases in which the indications for its use are not obvious, and in which its *methodus medendi,* if, indeed, it possess any curative power whatever, is unknown. In such cases we may term its use *empirical.*

1. *Paralysis.*—Electricity is sometimes beneficially employed in paralysis of sensation or of motion, or of both of these functions. Its operation is that of a peculiar and specific stimulus to the nerves; and hence it is most useful in those cases where these only are affected: while in paralysis from lesion of the nervous centres it holds out but little hope of relief.

In local paralysis, where a single muscle or a set of muscles only is affected; in paralysis arising from a torpid, inactive, or benumbed condition of the nerves themselves; in paralysis, stiffness, and rigidity consequent on chronic rheumatism, bruises, sprains, &c. and after all inflammation and tenderness have subsided; in paralysis arising from poisoning by lead; and, lastly, in all cases of what is sometimes termed functional paralysis, electricity frequently proves highly serviceable: and in some of these cases I have seen the most marked relief follow its use.

In paralysis from permanent organic lesion of the nervous centres, no benefit can be anticipated from its employment.

In the chronic form of paralysis which follows apoplectic attacks from cerebral hemorrhage it is frequently resorted to; but rarely with benefit. In all recent cases, and generally during the existence of inflammatory and febrile symptoms, its use is improper. It must never be applied until sufficient time has elapsed, after the occurrence of the hemorrhage, to allow of the absorption of the coagulum. But when there is reason to suppose or hope that the effused blood has become absorbed, and that paralysis remains from desuetude, the stimulation of the nerves and muscles of the part by an electric current deserves a trial, and may now and then prove serviceable. Moreover, the occasional exercise of the muscles of a paralysed limb, by a weak voltaic current, checks the shrinking of the muscles and loss of irritability consequent on their disuse.[1]

---

[1] Müller's *Physiology,* by Baly, vol. i. p. 635; Matteucci, *Traité,* p. 252; Todd and Bowman, *Physiological Anatomy,* vol. i. p. 243.

In the application of electricity to the treatment of paralysis, attention should be paid to the *force*, the *duration*, and the *direction* of the current.

a. Force of the Current.—At the commencement of the use of electricity, the current employed should be very feeble: afterwards its force must be adapted to the intensity of the malady. In slight cases, a weak voltaic current may be employed: in more severe cases, a more intense one, or the magneto-electric current, may be used. The shock produced by the discharge of a Leyden phial should be reserved for chronic cases of complete paralysis.

b. Duration of the Current.—This must be governed by the force of the current: the more powerful the current, the shorter should be its duration.

The interrupted or intermittent current should be preferred to the continuous one, care being taken not to apply it long enough to exhaust the excitability of the nerve.

Matteucci recommends that from twenty to thirty shocks should be communicated within two or three minutes, a few seconds being allowed to intervene between each shock. The patient should be then left undisturbed for a few minutes; after which the treatment may be renewed.

c. Direction of the Current.—This is determined by the kind of paralysis. In paralysis of sensation only, the current should be direct or centrifugal; in paralysis of motion, it should be inverse or centripetal. In paralysis both of sensation and motion Matteucci states there are no grounds for preferring the one direction to the other: but it appears to me that for such cases the vibrating current, obtained by the ordinary coil machine, is peculiarly appropriate; for by this the sensitive and motor nerves are alternately excited, while the one current promotes the restoration of the excitability, which may have been lessened by the preceding current.

The rule for adapting the direction of the current to the nature of the disease is founded on the assumption that, in some cases of paralysis, the nerves of the affected limb are in a condition similar to that produced by the continued passage of an electric current; and in order, therefore, to restore to the nerve the excitability of which the electric current had deprived it, the current must be reversed. Hence, to relieve paralysis, the current should be passed in a direction contrary to that which may have produced it. Now, as the sensitive nerves act centripetally, the current should be transmitted centrifugally when they are paralysed; and as the motor nerves act centrifugally, paralysis of them requires a centripetal current.

2. In *Amaurosis* of a torpid character, and without excitement, frictional electricity was formerly in considerable repute; but of late years it has fallen into disuse. Mr. Hey[2] published seven cases illustrative of its efficacy; but they are by no means satisfactory; for five of the patients were also mercurialized by calomel, and one received no benefit from the treatment employed. Mr. Ware[3] considered electricity more useful in amaurosis arising from the effect of lightning on the eyes than in any other variety of the complaint. This, indeed, theory leads us to expect.

The mode of using electricity in amaurosis is by the aura, or by slight sparks drawn from or directed against the eye and surrounding parts, or by the current passed either from one temple to the other, or from the superciliary and infraorbitary foramina to the occiput. Theory would indicate the transmission of the current from the hind part of the head to the face; that is, centrifugally as regards the optic nerve.

---

[1] Dr. J. Reid, *Edinb. Monthly Journ. of Medical Science*, May 1841.

[2] Hey, *An Account of the Effects of Electricity in Amaurosis*, in the *Medical Observations and Inquiries*, vol. v. p. 1, 2d edit. 1779.

[3] Ware, *Observations on the Cataract and Gutta serena*, Lond. 1812.

3. In *Nervous Deafness*, arising from a torpid condition of the auditory nerve, and unaccompanied with excitement, electricity, both frictional and voltaic, has been frequently employed; and though occasionally patients report themselves benefited by it, in most cases it fails to give relief, and in some instances has aggravated the malady. Both Itard[1] and Kramer[2] speak unfavourably of its effects. After quoting the opinions of most preceding writers on the subject, Kramer observes that, "Looking at the result of all this accumulated experience, given with the utmost honesty, there cannot be one moment's hesitation in declaring that electricity and galvanism are utterly useless in diseases of the ear; they even seriously endanger the auditory nerve by exciting to a morbid degree its irritability, the infallible result of which is, that it is positively debilitated." My own limited experience of its employment would not lead me to speak so unfavourably of its use.

4. In *Chorea*, considerable relief has sometimes followed the employment of frictional electricity; and I am acquainted with several cases in which its use appeared to be remarkably beneficial. Dr. Addison[3] and Dr. Golding Bird[4] also speak very decidedly of its good effects. I have, however, seen it fail to give relief in a considerable number of cases. Dr. Bird employed it in the form of sparks taken in the course of the spinal column every alternate day for about five minutes each time. Electric shocks transmitted along the limbs never appeared to him to do good, but, on the contrary, often aggravated the involuntary movements. I have seen electric friction in the course of the spine, and centripetally along the nerves of the extremities, apparently relieve the convulsive movements.

5. In *Tetanus*.—The use of electricity in tetanus was first suggested by Matteucci. "We have seen," says this philosopher[5], "that when the passage of the electric current through the nerves of a living or recently-killed animal is renewed many times successively, at short intervals, the limbs remain rigid by tetanic contraction. We know also that, on the contrary, the limbs are paralysed when the current is continued uninterruptedly for a certain time. Hence, then, the effects of the passage of a continued current are altogether different from those of the interrupted one. It was, therefore, natural to suppose that the continued current would destroy tetanus by inducing paralysis. Experience has fully established the accuracy of this conclusion. All narcotic poisons, such as opium and nux vomica, when given to frogs, first stupify, then overexcite them, and lastly, before death, give rise to very violent tetanic convulsions. Now if, during the latter stage, we pass through the animals a continued electric current of a certain intensity, the rigidity of the limbs ceases, and the convulsions disappear. The frogs die after a certain time, but

---

[1] Itard, *Traité des Maladies de l'Oreille et de l'Audition*, Par. 1821.

[2] *The Nature and Treatment of Diseases of the Ear*, by Dr. Wm. Kramer, translated from the German by Dr. J. R. Bennett, Lond. 1837.

[3] *Guy's Hospital Reports*, vol. ii. p. 493.

[4] *Ibid.* vol. vi. p. 84.

[5] *Traité*, p. 270.

without any symptoms of tetanus. In order to lessen the violence of the contractions which take place at the commencement of the treatment, it is better to use the inverse current.

"The application of the electric current in a case of tetanus which I published in the *Bibliothèque universelle*, for May 1838, appears to me to prove the correctness of my theoretical conclusions. During the time the patient was under the influence of the electric current, he did not experience the violent attacks which he had had previously. He was able to open and shut his mouth; and his circulation and transpiration appeared to be re-established. Unfortunately, however, these signs of amendment were only temporary; the disease being occasioned and kept up by the presence of foreign bodies in the muscles of the leg.

"I dare not hope that the application of the electric current will in general succeed in curing tetanus; but I think that I am justified in believing that it will relieve, in a great measure at least, the sufferings of the patient."

6. In *Amenorrhœa*, considerable benefit has been obtained by the employment of electricity. It is usually applied in the form of shocks produced by the discharge of a Leyden jar through the region of the uterus (from the sacrum to the pelvis, or from hip to hip). I have on several occasions found the practice successful.

[Reports of cases treated by electricity have been published by Drs. Bence Jones and Gull since the last edition of this work was published. Opinions appear to vary greatly as to the value of electricity as a remedy, and the whole question is at present in a most unsatisfactory state.—ED.]

7. *Other Uses.*—The preceding are the chief cases in which electricity is used at the present time. There are, however, many other maladies in which its employment has been suggested; but in some of which the chance of relief has appeared so slight, that the suggestion has never been acted on; in others, experience has not confirmed the expectations which were at first entertained of it; while, in a third class of cases, further experience is required to test its efficacy.

In *asphyxia* from drowning, hanging, the inhalation of noxious gases, &c., voltaic electricity has been unsuccessfully used to excite the muscles of respiration.[1] In *sanguineous apoplexy*, Dr. W. Philip suggested that it might be used to enable the lungs "to perform their functions for a longer time than without this aid," and that by it the life of the patient may be prolonged. In the asphyxia produced by *concussion*, galvanism has been suggested by M. Goudret.

Dr. Wilson Philip, having observed that withdrawing a considerable part of the nervous influence from the stomach and lungs deranges the digestive powers, and produces great difficulty of breathing, was led to expect relief from galvanism in *indigestion* and *habitual asthma*. He describes the benefit obtained as greatly exceeding his expectations. The positive pole is to be applied to the nape of the neck; the negative pole to the pit of the stomach. A weak power should be commenced with, and the strength gradually increased until some uneasiness is experienced. In some instances perfect cures were obtained; in others relief was gained.[2]

---

[1] The Professors of the Irish College of Surgeons, in 1829, failed to restore by it the respiratory movements in a person who had been hung (Dr. Apjohn, in *Cyclopædia of Practical Medicine*, art. *Galvanism*). Electricity, in conjunction with other means, was tried, but without success, in the case of Scott, the American diver, who had been accidentally hung for five or six minutes (see *Times*, Jan. 13, 1841).

[2] See *Phil. Trans.* 1817, p. 22; and Dr. Wilson Philip's *Treatise on Indigestion*. Also, La Beaume, *On the Medical Effects of Electricity and Galvanism in Nervous and Chronic Disorders*, 1820.

Prevost and Dumas[1] have proposed to *electrolyze urinary calculi* in the bladder, and thereby to effect their disintegration. Unfortunately, however, for this proposition, calculi are in general formed of substances which are insoluble, or nearly so, and which, therefore, cannot be decomposed by an electric current, unless it has a very great intensity, and is continued during a considerable time; in which case it will not be applicable.[2] Bonnet suggested that the bladder should be injected with a solution of nitrate of potash, and the calculus subjected to the action of electricity in this liquid, in order that the nitrate may be decomposed into nitric acid and potash; the former of which it was suggested would dissolve the phosphates, while the latter would dissolve the uric acid and urate of ammonia. [A paper by Dr. Bence Jones has been lately published in the Philosophical Transactions,[3] containing the views above noticed, and published by Bonnet some years ago. Thus, Dr. B Jones proposes to act upon the calculus by decomposing a solution of nitrate of potash in the bladder by means of electricity. This is nothing more or less than Bonnet's view.—ED.]

If the poles or electrodes of a voltaic battery be immersed in an albuminous liquor, the albumen becomes coagulated. On this fact it has been suggested "that galvanism might be applied to the important purpose of *coagulating the blood within an aneurismal tumour*, and thus removing the disease without resorting to the ligature."[4] For this purpose two needles are to be introduced into the tumour, and their projecting extremities connected with the opposite electrodes of the battery.

Pravaz[5] has proposed to *cauterise* the bites inflicted by rabid animals, by introducing the electrodes of a battery into the wound; and Fabré-Palaprat[6] has suggested that the cauterizing effects of the moxa might be effected by voltaic electricity; and in this way a *galvanic moxa* formed.

In 1832, Dr. Coster,[7] and in 1833, M. Fabré-Palaprat,[8] employed voltaic electricity *to assist the introduction of certain medicinal substances into the blood.* M. Fabré-Palaprat asserts that, by the aid of galvanism, he has caused certain chemical agents to traverse the body and appear at some distant part. He bound on one arm a compress, moistened with a solution of iodide of potassium, and covered by a platinum disk, connected with the negative pole of a voltaic battery of thirty pairs of plates. On the other arm was placed a compress, moistened with a solution of starch, and covered by a platinum disk, connected with the positive pole of the battery. In a few minutes the starch acquired a blue tinge, shewing that the iodine had been transported from one arm to the other. I have twice repeated Fabré-Palaprat's experiment; but, though I employed fifty pairs of plates for fifteen minutes, I was unable to obtain the slightest evidence of the passage of iodine through the body.

Electric friction, or slight shocks, are sometimes employed *to promote the biliary secretion;* but I have had no experience of their good effects.

To promote the resolution of indolent tumours, electricity, in the form of sparks, slight shocks, and friction, has been employed, and, it is said, with occasional benefit. I have tried it in several cases of enlarged cervical glands, but without observing that any benefit resulted therefrom.

It has been proposed *to destroy opacity of the crystalline lens* by electricity; but, as Matteucci[9] has shrewdly observed, "though it is possible to make a cataract by the electric current, it is not possible to destroy one by it."

Electricity has been recently applied by Dr. Radford[10] *to produce uterine contractions* in cases of severe flooding attended with exhaustion. Dr. Radford states, that it excites not only tonic contraction, but also alternate contraction, when applied at intervals. In one case he used it where the membranes were unruptured, and the uterus in a state of great inertia; and alternate contraction was immediately produced. He also suggests the use of this agent in tedious labours depending upon want of power in the uterus, and where no mechanical obstruction exists; in cases where it is desirable to produce premature labour; in menorrhagia where the uterus is flaccid, and the os uteri patulous; and in hour glass contraction, to excite the longitudinal uterine fibres. The apparatus employed by Dr. Radford was a coil machine; one pole being applied to the abdominal parietes over the fundus uteri, the other pole to the os uteri. The vaginal conductor "consists of a strong brass stem, seven inches long, curved to suit the vagina, and covered with a non-conducting material, having a small screw at its distal extremity for attaching it to a silvered ball; at its other extremity it is received within an ebony handle, which is hollow and through which passes a strong brass wire, looped at the end, and connected with the long wires before alluded to. The wire is kept disconnected from the brass stem by means of a spiral spring concealed within the ebony handle. The loop is covered with silk, and is intended for the thumb of the operator when he is bringing the wire into connection with the stem. When the remedy is applied, the brass ball of the vaginal conductor is to be passed up to the os uteri, and moved about at intervals on to various parts of this organ."

---

[1] *Journal de Physiologie*, t. iii. p. 217.

[2] Dr. Ludwig Melicher, of Vienna, is said to have had two successful cases of destruction of calculi in the living human subject by electric decomposition (vide *Oesterreichische medicinischen Jahrbucher*, 1848).

[3] 1853. Part ii.

[4] Apjohn, *Cyclopædia of Practical Medicine*, art. *Galvanism.*

[5] *Revue Médicale*, Dec. 1830.

[6] *Du Galvanisme appliqué à la Médecine*, p. 57, Paris, 1828.

[7] *Archives Générales de Médecine*, t. ii. p. 432.

[8] *Ibid.* 2me serie, t. ii. Also, Becquerel, *Traité de l'Electricité*, t. iv. p. 321.

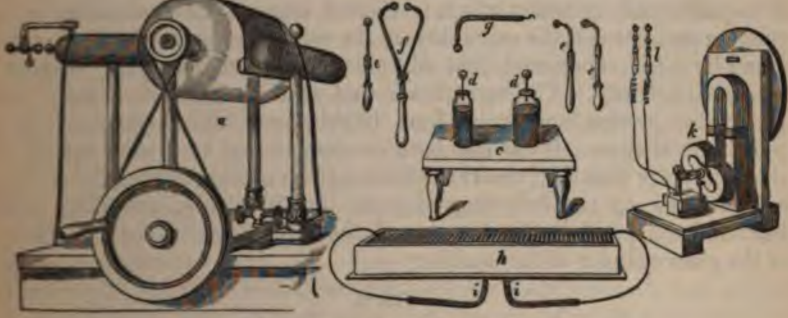
[9] *Traité*, p. 272.

[10] *Provincial Medical Journal*, Dec. 1844. Also, Rankin's *Half-Yearly Abstract*, vol. i.

MODES OF PRODUCTION OF ELECTRICITY FOR MEDICAL PURPOSES.—The sources of electricity are numerous; but of these a few only have been resorted to for obtaining electricity for medical purposes. They are—

1st. Friction, as in the common electrical machine.
2dly. Chemical action, as in the voltaic battery.
3dly. Magnetism, either of temporary magnets, as in the coil machines, or of permanent magnets, as in the magneto-electric machines.

FIG. 1.



Electrical Apparatus for Medical Purposes.

FRICTIONAL ELECTRICITY.

a. Cylinder machine.
b. Medical electrometer.
c. Insulating stool.
d d. Leyden jars.
e e e. Insulated directors.
f. Discharging rod.
g. Glass tube traversed by a wire, which terminates at one end by a loop, at the other by a brass ball.

VOLTAIC ELECTRICITY.

h. Cruickshank's wooden trough.
i i. Directors, each consisting of a glass tube traversed by a wire, an extremity of which is connected with one end of the trough; while the other extremity is surmounted by sponge or flannel moistened with salt and water.

MAGNETIC ELECTRICITY.

k. Clarke's magneto-electric machine.
l. Directors.

1. FRICTIONAL ELECTRICITY.

(Common or Franklinic Electricity.)

APPARATUS.—The apparatus requisite for the medical application of frictional electricity consists of the following instruments :—

1. *A cylindrical or a plate machine* (fig. 1, *a*). If a cylinder, the diameter should be at least from 8 to 14 inches; if a plate, from 18 to 24 inches. The amalgam used for the rubber is composed of one part tin, two parts zinc, and six parts mercury. The conductor intended for the reception of the electricity is denominated the *positive conductor ;* while the conductor attached to the cushion, or rubber, is called the *negative conductor*. Some machines, however, are not fitted up with the latter.
2. *Lane's medical electrometer*, to regulate the force of the spark or shock (fig. 1, *b*).
3. *One or two Leyden jars :* if more than one, they should be of unequal size (fig. 1, *d d*).
4. *An insulating stool or chair* (fig. 1, *c*).
5. *A discharging rod* (fig. 1, *f*).
6. *Two or three insulated directors* (fig. 1, *e e e*). The brass ball which surmounts each director may be occasionally unscrewed and removed, and a metallic or wooden point substituted.
7. *Flexible metallic wire or chain*. A brass chain is generally employed; but the spiral brass wire employed for braces is more convenient; it may be enclosed within a thick silk ribbon.
8. *An ear tube* (fig. 1, *g*) consisting of a narrow glass tube, traversed by a brass or copper wire, which terminates at one end in a small brass ball, at the other by a loop.

The common electric machine yields, by the friction of its glass cylinder or plate on the rubber, a *small quantity* of electricity of *high tension*, or whose elasticity is great, and which, therefore, is capable of exerting attractive and repulsive forces not merely at sensible, but at considerable, distances. The quantity of electricity which is elicited depends on the extent of the rubbing surfaces and the suitability of the substances used. "It has been found by direct experiment, that all kinds of glass are not equally adapted to give out electricity. The best glass is that which is the whitest, most transparent, the hardest and freest from bubbles, and which contains a large proportion of silex. It has also been ascertained that it should not be too thick, in order that the [electrical] fluid may be quickly excited[1]."

The arrow in the following diagram (fig. 2) shows, according to the Franklinian hypothesis, the direction of the current set up by the rotation of the glass cylinder of the machine :—

FIG. 2.

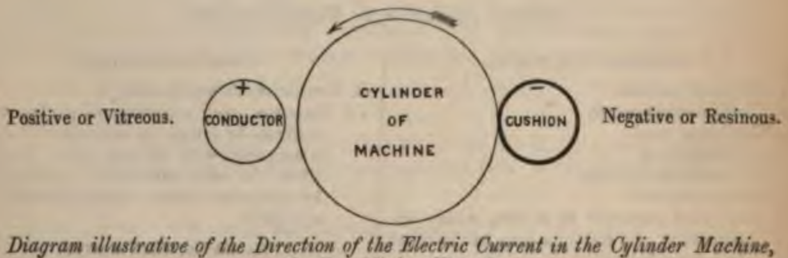


Diagram illustrative of the Direction of the Electric Current in the Cylinder Machine, on the Franklinian Hypothesis.

---

[1] Peschel's *Elements of Physics*, by West, part iii. p. 32, Lond. 1846.

The glass robs the cushion of electricity, and yields it up to the conductor: the cushion, therefore, becomes negative, while the conductor becomes positive.

FORMS AND MODE OF APPLICATION.—Frictional electricity may be applied medicinally in five forms; viz. the *bath*, the *aura*, the *spark*, the *shock*, and the *current*.

1. *The Electric Bath.*—In this mode of employing electricity the patient is placed on the insulating stool (or chair), and in connection with the prime conductor of the machine. The whole surface of the body becomes electro-positive, while the air which surrounds the body is, by induction, rendered electro-negative. The positive electricity is constantly and silently discharged from all pointed parts of the surface, as from the hairs, fingers, &c. In a darkened room the discharge is seen to be attended with the evolution of light. The effect of the electric bath is not constant (see p. 37).

2. *Electric Aura.*—This is produced by the action of a current of electrified air on the skin. It is applied by means of an insulated pointed director, connected with the prime conductor by a wire or chain; its point being turned to the part intended to be electrified. In this way a current or breeze of highly excited air is directed towards the part. Or the aura may be drawn from the patient while placed on the insulating stool, by means of an uninsulated metallic point. The electric aura operates as a mild stimulant, and is occasionally used when we are desirous of electrifying delicate parts; as the eye, ulcers, excoriated surfaces, the testicles, &c.

3. *The Electric Spark.*—This is one form of the disruptive discharge. It may be communicated by presenting to the part to be electrified the ball or knob of an insulated director connected with the prime conductor. Or it may be drawn from the patient by placing him on the insulating stool (or chair), and bringing the knuckle or the ball of an uninsulated director near him. The opposed surfaces, between which the spark passes, are in oppositely electrified conditions. The nearer they are together, and the smaller the ball, the weaker is the force of the spark. A succession of very small sparks is obtained by substituting a wooden point for the metallic ball.

The spark occasions a sharp, painful, pungent sensation, redness, and sometimes a small circumscribed spot or wheal, which, however, in general quickly disappears.

For internal parts, as the bottom of the meatus auditorius externus, a glass tube is used to insulate the conducting wire, the end of which terminates in a very small knob, contained within, or placed at the end of, the tube (fig. 1, *g*).

A favourite mode of employing electric sparks is *to draw them through flannel*, as recommended by Cavallo[1]. This method is called by some electricians *electric friction*. The patient, being placed on the insulating stool, takes hold of the chain communicating with the prime conductor by the hand opposite to the side to be electrified. Over the naked part is then placed a piece of flannel, and, the machine being turned, the operator places the knob of an uninsulated director in close contact with the flannel, and moves it steadily, but rapidly, so as to draw a vast number of very small sparks. It is said that the motion of the ball should be down the part affected; that is, in the direction of the ramifications of the nerves. The operation is to be continued for twenty or thirty minutes. It excites warmth, but no very disagreeable sensations. When an uneven surface (as of the face and hands) is to be electrified, the ball of the director should be covered with flannel.

---

[1] *Complete Treatise on Electricity*, vol. ii. p. 136, 3d ed. Lond. 1786.

4. *The Electric Shock.*—This is a violent effect of the disruptive discharge, and is thus effected :—Charge a Leyden jar; then connect its outside by a chain or wire with the ball of an insulated director, which is to be applied to one extremity of the part through which the electricity is intended to pass. The knob of the jar is then applied to the other extremity of the part, and the discharge instantaneously takes place.

The force or the strength of the charge is graduated by interposing in the circuit a medical electrometer (see fig. 1, *b*), which is employed thus :—Place the Leyden jar so that its interior may be in communication with the prime conductor, while its exterior is connected with the patient by a chain and insulated director. One of the knobs of the electrometer is then put in communication with the opposite side of the patient by a second chain and director. If the machine be now turned, the jar charges, and, when the tension is sufficiently high, a spark passes from the prime conductor to the ball of the electrometer, and the discharge takes place, the patient experiencing the shock. To increase or diminish the force or strength of the shock, we augment or lessen the space between the prime conductor and the ball of the electrometer.

Sometimes a coated glass tube is substituted for the Leyden phial in the above arrangement, the medical electrometer being employed. The patient then receives a rapid succession of slight shocks, constituting what some electricians denominate *electrical vibration*.

When a portion of the body makes a part of the circuit through which the discharge of a Leyden phial is effected, a sudden, instantaneous, and painful sensation is produced, which is denominated *the shock*. If the charge be passed through the arms, the effects are principally experienced in the wrists, elbows, and across the breast. If the diaphragm form part of the circuit, it is immediately thrown into a temporary state of contraction. If a strong charge of a battery be passed through the head of a rabbit, temporary blindness or death ensues. In persons killed by lightning, red streaks are frequently observed on the skin. It is said that marks are often observed indicating the passage of the electric fluid along the spine. The blood is usually fluid, and the muscles flaccid; though occasionally rigidity of muscles and blood capable of coagulation have been found.

The greater or less violence of the shock depends not on the quantity merely, but also on the intensity of the charge. Thus a small jar highly charged will produce a greater effect than a large battery feebly charged. But of course, if the intensities be equal, the greatest shock is perceived when the largest quantity is employed.

5. *The Electric Current.*—To cause a current to pass through a patient to the ground, connect some part of the body directly, or indirectly by a chain or wire, with the prime conductor of the machine; the patient standing on the ground. By this means the current passes into the body at the point of connection, and escapes by the feet. Its effects are exceedingly slight, and scarcely, if at all, obvious.

2. VOLTAIC ELECTRICITY.

(Galvanism; Voltaism; Chemical Electricity; Contact Electricity.)

APPARATUS.—The apparatus required for the medical application of voltaic electricity consists of—

1. *A compound hydro electric battery*, commonly called a *voltaic* or *galvanic battery*. Notwithstanding the improvements which have of late years been effected in the construction of voltaic apparatus, the battery devised by the late Mr. Cruickshank is, for medical purposes, decidedly to be preferred to other batteries of later construction, on the ground both of cheapness and convenience.

It should consist of from 50 to 100 pairs of plates (copper and zinc), each from 2 to 4 inches square, and arranged in one or two wooden troughs (*Cruickshank's troughs*). In most cases, one trough of 50 pairs will be found sufficient. When two troughs are employed they must be connected together endwise by slips of sheet copper, or stout copper wire—the zinc end of one trough with the copper end of the other trough.

The liquid used to excite the battery may be common water, a solution of common salt, or water acidulated with hydrochloric or sulphuric acid. Common water is employed where very feeble effects are required; as where the skin is very susceptible of the voltaic influence. Acidulated water is used where the most powerful effects are required. One part of hydrochloric acid, and from sixteen to twenty parts of water, may be used. Singer, however, used only one part of acid to five hundred of water. One part of oil of vitriol, and from twenty to thirty parts of water, form as strong a charge as in general is likely to be required. The use of nitric acid is objectionable on account of the nitrous fumes which are evolved.

2. *A pair of insulated directors*, each containing a glass tube traversed by a copper wire. One extremity of the wire is in communication with one end of the trough; the other extremity is covered with sponge or flannel, moistened with a solution of common salt.

3. *Copper wire* to connect the directors with the ends of the troughs.

[*Compound Voltaic Circuits.*—The application of the compound voltaic circuit has been largely prescribed of late, and has almost become a popular remedy in the form of Pulvermacher's galvanic chains. These are made of two metallic elements ingeniously woven together, and when moistened with water, dilute acid, or a saline solution, they may be applied to the part affected, or worn so as to encircle it. They are recommended for cases of rheumatism, paralysis, &c., and are regarded by some practitioners as a valuable and convenient means of applying a continuous current of voltaic electricity.—ED.]

Simple Voltaic Circuits.—These are occasionally employed as popular remedies, either in the form of Harrington's electrizers or as galvanic rings.

Harrington's electrizers are plates of copper and zinc, or of silver and zinc, made in various forms. Thus for the toothache a plate of copper is soldered edgewise to one of zinc, and worn in the mouth: the saliva serves to excite the apparatus. In another contrivance, an hexagonal plate of zinc is connected by its face to a plate of silver; and a series of these compound plates are connected together by wire, so as to move on each other like hinges. These are worn next the skin for the relief of rheumatism. The perspiration serves to excite the plates. Silver and zinc spangles also have been employed, instead of the plates just mentioned.

Galvanic rings are constructed of copper and zinc, or of silver and zinc. The perspiration is supposed to excite them.

The *intensity* of the electricity evolved by the voltaic battery depends on the number of plates used, and on the chemical nature of the liquid employed to charge the battery. By increasing the number of plates, we proportionately augment the intensity of the electricity; and by increasing the intensity of the chemical action going on in the cells, we also heighten the intensity of the electric current. Thus, the intensity of the current evolved by the use of a solution of common salt is greater than that produced by common water; but is less than that obtained by an acidulated liquid. Moreover, diluted nitric acid yields a more intense current than diluted sulphuric acid.

The *quantity* of electricity evolved by the voltaic battery depends on the size of the plates. But, as plates of from two to four inches square evolve as large a quantity of electricity as is required for medical purposes, it is useless and wasteful to employ plates of larger size.

> "This strongly marked distinction in the capacities of batteries, consisting of small pairs of plates, and those which are composed of a few large pairs, admits of a satisfactory explanation by Ohm's law.[1] In any case when it is desired that the current should exert a powerful influence on some bad conducting substance, the density of the electricity must be increased as much as possible by employing a great many pairs of plates; and thus the resistance offered to the conduction and transmission of the fluid through its circuit by the interposition, for example, of the human body, is easily overcome: this end would not be attained by increasing the quantity of the electricity, which we might do either by increasing the effective surface or by using more powerful combinations, because, by either of these means, we should reduce only the resistance that we meet with in the battery itself, and that, compared with the resistance of the non-conducting substance that forms a part of the circuit, is, after all, but very small. So, also, we can easily explain why these effects are rendered still more powerful if that portion of the human frame which is enclosed within the wires be moistened with some liquid that is a good conductor: the effect is heightened still further if large metallic surfaces, instead of merely the points of the wires, are brought into contact with the body: by either of these modes, the strong resistance which the human frame offers to the transmission of the electricity is much lessened.
>
> "Suppose we use a single pair of plates, whose electro-motive power we will call 1, and that the resistance of the human body which forms a part of the circuit is 100 times greater than that of the pair of plates; then, by Ohm's formula, the effect of the current on the body may be expressed by the fraction $\frac{1}{1+100}=\frac{1}{101}$. Next use a battery consisting of 100 such pairs, and its effect will be represented by $\frac{100}{100+100}=\frac{1}{2}$, which is much greater than that of the single pair. Now, if we were to employ a single pair of plates with an electro-motive force 100 times greater than that of the pair first spoken of, or, in other words, one whose resistance to conduction shall be 100 times less than that of the former, the effect of its current on the human frame would be only $\frac{1}{\frac{1}{100}+100}=\frac{1}{100{\cdot}01}$, which is but very little more than that of the first pair, whose electro-motive power we supposed to be only $\frac{1}{100}$th of the power of the latter pair."[2]

The direction of the current in the voltaic battery is, on the Franklinian hypothesis, from the more oxidable metal (zinc) to the liquid, and from this to the less oxidable metal (copper, silver, or platinum), as in fig. 3.

FIG. 3.

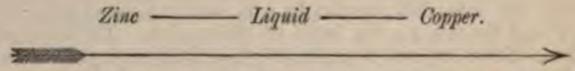


Diagram illustrative of the Direction of the Voltaic Current on the Franklinian Hypothesis.

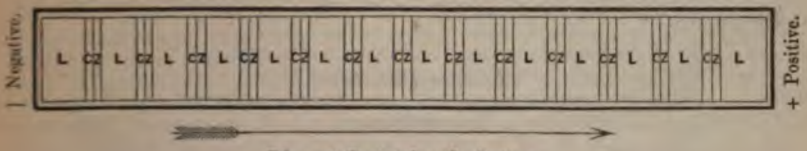
In Cruickshank's battery, the direction of the current is, therefore, as shewn by the arrow in the following diagram (fig. 4), in which L indicates the liquid, C the copper plate, and Z the zinc plate:—

---

[1] Taylor's *Scientific Memoirs*, vol. ii. p. 401.

[2] Peschel's *Elements of Physics*, part iii. p. 115–116, 1846.

FIG. 4.


– Negative.
L CZ L CZ L CZ L CZ L CZ L CZ L CZ L CZ L CZ L CZ L CZ L CZ L CZ L
+ Positive.

Plan of Cruickshank's Battery.

FORMS AND MODE OF APPLICATION.—In all experiments with the voltaic apparatus, care must be taken that the various parts, by which connection is made, are perfectly clean, so as to ensure good metallic contact. This is necessary on account of the low intensity of this form of electricity compared with that obtained by the ordinary frictional machine; so that films of oxide, dirt, varnish, &c. readily obstruct the passage of the electricity, and greatly interfere with the action of the battery. On this account, therefore, the extremities of the conducting wires should be carefully cleaned by sand-paper.

Voltaic electricity is usually employed in the form of the *current;* but when an extended series of plates is employed, and energetic chemical agents used to excite them, *shocks* are obtained.

1. *The Voltaic or Galvanic Current.*—This may be administered by interposing between the terminal poles of the battery any portion of the human body through which it is desired to transmit the current. The parts of the body with which the poles are placed in contact should be moistened with water if slight effects are required, or with salt and water when more powerful effects are desired. We do this in order to facilitate the passage of the electricity which, on account of its low intensity, is obstructed by the resistance offered by the dry cuticle. Or the parts may be covered by a sponge or flannel moistened with water, or with salt and water. Or, in the case of the extremities, one extremity may be immersed in water, or in salt and water, connected with one pole of the battery, and contained in a basin; while the other extremity is immersed in another basin of water, or of salt and water, similarly connected with the other pole of the battery. The effect of the battery is greatly heightened by using for the terminal conductors or poles large metallic surfaces. Thus, if it be required to pass a strong current through the arms, let the patient grasp, with his hands well moistened with salt and water, two metallic cylinders connected with the battery.

The number of plates used must depend on the effects produced. It is better, therefore, to commence with a small number (say from 5 to 10), and gradually increase the number until the required intensity be obtained.

As the most powerful effects of the current are produced at the moment of closing or opening the circuit, we can augment the effects by alternately making and breaking the contact of the poles with the body. This is sometimes effected by the rotation of a toothed wheel.

2. *The Voltaic or Galvanic Shock.*—This is effected in the same way as the current, but using a more extensive series of plates (from 50 to 100 pairs), exciting them by an acidulated solution, and employing the means above mentioned for effecting and breaking contact. "The shock of a voltaic

battery may be distinguished from that of common electricity, inasmuch as the latter is felt far less deeply, affecting only the outer part of our organs, and being exhausted in a moment. The voltaic shock, on the contrary, penetrates farther into the system; propagating itself along the entire course of the nerves."[1]

Electro-Puncture.

(Galvano-Puncture.)

The operation of electro-puncture was proposed by Sarlandière,[2] in 1825. It consists in introducing two acupuncture needles in the usual way, and connecting them with the poles of a weak voltaic battery; the contact being occasionally suspended and renewed, in order to produce a succession of shocks. This practice has been successfully adopted for the relief of rheumatism, neuralgia, local paralysis, sciatica, spasmodic affections, and other maladies in which the operation of simple acupuncture has been used, than which it has been thought, by some, to be more efficacious. In neuralgia and in rheumatism it should be employed only in the interval of the paroxysms[3]. M. Bourgeois[4] proposed to employ the operation of electro-puncture of the heart, to promote resuscitation, in cases of asphyxia. Majendie[5] employs electro-puncture in incomplete amaurosis with great success. "This is done by passing down fine needles through any of the branches of the frontal and superior maxillary nerves, a slight pricking sensation indicating that the nerve is pierced; a galvanic current is then passed along the needles through the branches of the fifth nerve."

3. MAGNETIC ELECTRICITY.

Magnetism, when conjoined with motion, excites, by induction, dynamical electricity. Being itself a statical force, it requires the superaddition of motion to produce a dynamical force.[6]

APPARATUS.—The magnets used for the production of magnetic electricity are either *temporary* or *permanent*. Machines in which the former are employed are commonly known as *coil machines;* while those in which the latter are used are called *magneto-electric machines*.

a. Coil Machines.

(Volta-electric Induction Machines; Galvano-magnetic Induction Machines; Electro-dynamic Machines.)

These machines are variously constructed. They consist essentially of the following parts:—

1. *A single voltaic pair.* This is usually called *the battery*. The most convenient

---

[1] Peschel, *op. cit.* part iii. p. 118.

[2] *Mémoires sur l'Electro-puncture*, Paris, 1825.

[3] Trousseau and Pidoux, *Traité de Thérapeutique*, t. i. p. 579, Paris, 1836.

[4] Quoted by Merat and De Lens, in the *Dict. Univ. de Mat. Méd.* art. *Electro-puncture.*

[5] Mackenzie, *A Practical Treatise on the Diseases of the Eye*, p. 857, 3d ed. 1840.

[6] Grove *On the Correlation of Physical Forces*, p. 32, 1846.

construction is that of Mr. Smee, consisting of platinized silver and amalgamated zinc, immersed in water acidulated with about one-eighth part by measure of oil of vitriol.

In the *Improved Graduated Galvanic Coil Machine*, made by Hearder, of Plymouth, the platinised silver plate is one inch and a quarter wide, and three inches long. The acid mixture used to excite this battery consists of one measure of oil of vitriol, and seven measures of water.

2. *A primary and a secondary coil or helix* (made of covered copper wire), *with a core* (consisting of a bundle of soft iron wires), *and a contact-breaker*. The wire composing the *primary, inner*, or *quantity coil* is shorter, but thicker, than that forming the *secondary, outer, induction*, or *intensity coil*. The actual thickness and length of the wires vary in different machines. In a coil machine for medical purposes, made by Mr. Newman, of Regent Street, the primary coil contains 80 feet of No. 16 wire; and the secondary coil, 360 feet of wire of about the $\frac{1}{100}$th of an inch in diameter.

3. *A pair of brass or copper directors with glass handles*. The extremity of each director should be armed with a circular brass or copper disk, of about an inch in diameter, covered with sponge or flannel, moistened either with water or a solution of common salt.

When the two extremities of the primary coil are respectively connected with the two poles of the voltaic pair, a voltaic current (called the *primary* or *quantity current*) traverses the primary coil. At the instant of making and breaking contact between the battery and the primary coil, a momentary voltaic current (called the *induced* or *secondary* or *intensity current*) is induced in the secondary coil.

The secondary current obtained by making contact is in the reverse direction to that of the primary current; while that produced by breaking contact is in the same direction as the primary current.

The wires composing the *core* placed in the common axis of the two coils are, during the period of the passage of the voltaic current through the primary coil, magnets (*temporary* or *electro-magnets*): they greatly augment the intensity of the secondary current.

As the secondary current exists only at the moment of making and breaking contact, the use of the *contact-breaker* is obvious.

The secondary current, on account of its having a much higher intensity than the primary current, is used for its physiological influence. As obtained by the apparatus above described, it is an alternating, vibrating, or to and fro current: that is, at the moment of making contact it is in one direction, and at the time of breaking contact it is in the reverse direction. By a slight alteration in the construction of the contact-breaker, this reverse secondary current may be intercepted,[1] and we then obtain an intermitting current in one direction only.

The regulation or graduation of the shock is effected in these machines in various ways. One method is by withdrawing partially the core from the axis of the coils: the more it is withdrawn, the less powerful will be the shock.

Another method is by varying the length of the wire composing the secondary coil. This is the method adopted by Hearder in the machine before referred to. By means of a graduated regulator, having a moveable index, no less than sixteen different degrees of power are obtained; the lowest being that produced by a secondary wire of 80 feet in length, the highest by one of 320 feet long.

A third method is the interposition of an imperfect conductor in the circuit of the secondary wire, by which the resistance to the progress of the electricity is augmented. Bonijol, of Geneva, uses for this purpose a water tube, with the conducting wire in contact with the water at each end of the tube. By varying the distance between the extremities of these two wires, or by making them touch each other, the intensity of the shock may be graduated.

---

[1] Dr. Letheby, *London Medical Gazette*, N. S. vol. iii. p. 858, 1846.

The shock of the coil machine is administered as follows:—Having connected the battery with the primary coil, and the directors with the secondary coil, place the moistened extremities of the directors in contact with the two parts of the body between which it is desired that the shock should be passed. Or, if it be desired to pass the shock through the extremities, two basins of water or salt and water, connected respectively with the terminals of the secondary coil, may be used as before described under the head of "Voltaic Electricity."

Dr. Radford's mode of transmitting the current through the uterus has been already noticed (p. 48).

β. *Magneto-electric Machines.*

The apparatus required for the medical application of magnetic electricity consists of—

1. *A magneto-electric machine.* The most convenient, simple, and powerful magneto-electric machine is that devised by Mr. E. M. Clarke, of the Strand. It consists of a battery of six curved *permanent magnets,* and an *intensity armature,* around whose cylinders 1500 yards of fine insulated copper wire are coiled (*intensity coil*).
2. *A pair of directors.* Each of the directors holds a piece of sponge or flannel dipped in vinegar or a solution of common salt.

The ends of the wire composing the *intensity coil* are to be connected with the directors, and these applied to two portions of the living body. When the armature is rotated, a succession of shocks is received by that portion of the living body interposed between the directors.

A magneto-electric machine, like the voltaic battery and coil machines, is not affected by the moist state of the atmosphere: this gives it an advantage over the common electric machine; and as acids are not required to excite it, one inconvenience of the voltaic battery and coil machines is obviated.

It is employed in medicine as a substitute for the ordinary voltaic battery and coil machines. The current it gives is an alternating or vibrating one, such as I have before alluded to (see pp. 45 and 57).

5. MAGNETISMUS.—MAGNETISM.

(*Mineral Magnetism.*)

HISTORY.—Aëtius,[1] who lived about A.D. 550, is the oldest author who expressly mentions the application of magnetism to the cure of diseases; for, although Hippocrates[2] speaks of the magnet as a remedial agent, he refers to its internal use only. Subsequently to Aëtius, a considerable number of writers have noticed the supposed therapeutical powers of magnets.[1] About the end of the seventeenth century, magnetic tooth-picks and ear-picks were made as secret preventives against pains in the teeth, eyes, and ears.[2]

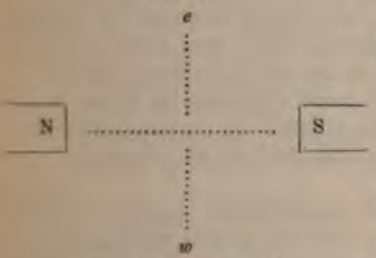
---

[1] *Sermo* ii. cap. 25.

[2] *Opera; De intern. affect.* p. 543; and *De his quæ uterum non gerunt,* p. 686, ed. Fœsii.

GENERAL REMARKS.—The recent researches of Dr. Faraday[3] have shown that all matter is "subject to the magnetic force as universally as it is to the gravitating, the electric, and the chemical or cohesive forces. But all substances are not affected by the magnetic force in the same manner. Some, when suspended in the magnetic field, arrange themselves axially, or in the lines of magnetic force: these are said to be *magnetic*.

FIG. 5.



The Magnetic Field.

NS, the *axial* direction, or the direction from pole to pole, or the line of magnetic force.

e w, the *equatorial* direction, or the direction perpendicular to the axial direction, and across the line of magnetic force.

Others, however, whose form is elongated, arrange themselves equatorially, or at right angles to the lines of magnetic force, when similarly suspended: and these are said to be *diamagnetic*.

From Dr. Faraday's experiments, it appears that, "besides iron, nickel, and cobalt, the following [metals] are also *magnetic;* namely, titanium, manganese, cerium, aluminum, osmium, chromium, palladium, platinum."

[Oxygen has also been proved magnetic by the recent researches of the same philosopher. Thus a soap-bubble filled with oxygen is strongly attracted by the magnet, while soap and water alone can be shown to be *diamagnetic*.[4]—ED.]

The class of *diamagnetic* bodies is a very extensive one, and includes bismuth, antimony, and many other metals, rock crystal, many earthy and alkaline salts, vegetable and mineral acids, water, alcohol, phosphorus, sulphur, sodium, iodine, gum, starch, several oily, fatty, and resinous substances, ivory, flesh, blood, &c. "I was much impressed by the fact," says Dr. Faraday, "that blood was not magnetic, nor any of the specimens tried of red muscular fibre of beef or mutton. This was the more striking because iron is always, and in almost all stages, magnetic."

The same philosopher also observes that, "if a man could be suspended, with sufficient delicacy, after the manner of Dufoy, and placed in the magnetic field, he would point equatorially; for all the substances of which he is formed, including the blood, possess this property."

PHYSIOLOGICAL EFFECTS.—As all substances are under the influence of the magnetic force, it might be expected that the vital functions would suffer some modification from the action of magnetism on organised bodies; but hitherto no conclusive and unequivocal evidence on this point has been obtained.

---

[1] See the very elaborate and able *Mémoire sur le Magnétisme médicinal*, by MM. Andry and Thouret, in the *Mémoires de la Société Royale de Médecine*, Année 1779, p. 531.

[2] Beckmann, *History of Inventions and Discoveries*, vol. i. p. 74.

[3] *Phil. Trans.* for 1846.

[4] Some recent observations of Dr. Faraday, having reference to the daily variation of the needle, tend to prove the phenomenon probably dependent on the magnetic condition of oxygen as varied by temperature.

Various phenomena have been ascribed to it; but the inconstancy of their occurrence throws great doubt over the opinion that they are really the effects of the magnetic force.[1] The failure of their production in persons on whose statements confidence can be placed, and their occurrence chiefly in females, and in those called nervous, are reasons for suspecting some error or fallacy in the statements of practitioners who advocate the influence of magnetism on the vital functions.

Dr. Faraday does not appear to be susceptible of the magnetic force; for some years ago he allowed Dr. Keil to try, in a variety of ways, the influence of powerful magnets on him, but no perceptible effects were produced;[2] and he informs me that he was never sensible of any effect produced on him by the powerful magnets which he used in his recent experimental investigations on magnetism (see *Phil. Trans.* for 1846), although he purposely submitted various parts of his body to their influence, and tried in all imaginable ways to obtain some evidence of their effect.

On healthy sensitive[3] individuals, says Reichenbach, magnets of 10lb. supporting power, when drawn along the body downwards without contact, produce a sensation rather unpleasant than agreeable. It is "like an *aura;* in some cases warm; in others cool; or it may be a pricking, or a sensation of the creeping of insects on the skin: sometimes headache comes on rapidly." Diseased sensitive subjects "experience different sensations, —often disagreeable, and occasionally giving rise to fainting, to attacks of catalepsy, or to spasms so violent that they might possibly endanger life."[4]

Becker[5] states that the sensations which his patients experienced from the use of the magnet were, 1st, *cold* (probably from the coldness of the steel); 2dly, *heat* (this is the most frequent effect, especially in the ears, and it often amounts to unpleasant burning); 3dly, *traction* (from the slightest degree, when it is an agreeable feeling, to the strongest, when it is almost painful, like that of a cupping-glass); 4thly, *an indefinite sensation* (in the ear, called a working or roaring); 5thly, *throbbing;* 6thly, *pain;* and 7thly, *numbness* or *loss of feeling in the magnetised part.*

---

[1] Reichenbach believes that the power of acting on the nervous system enjoyed by artificial magnets is also possessed by the earth's magnetism; by the rays of the sun, moon, and other heavenly bodies; by heat, light, electricity, and chemical action; by crystals; by living persons; and, in a word, by material substances generally. This force or power forms a part, he says, of what is usually called magnetism, and is probably the agent in animal magnetism; but, in reality, it is a force or influence distinct from all known forces; and he proposes, therefore, to call it *od* (a name not possessing any meaning), and according as it is found in crystals, magnets, the living body, heat, light, &c. he terms it *crystallod, magnetod, biod, thermod, photod,* &c. (*Researches on Magnetism and on certain Allied Subjects,* by Baron von Reichenbach, translated and abridged by Dr. Wm. Gregory, Lond. 1846).

[2] *Lancet* for 1835–36, vol. i. p. 716.

[3] Persons susceptible of the magnetic influence are said to be *sensitive.*

[4] Reichenbach states, that diseased sensitive subjects enjoy an extraordinary acuteness of the senses. The poles and sides of powerful magnets, the poles of crystals, the human hand, &c. are luminous to them. Luminous appearances (*corpse-lights; ghost-lights*) are also seen by them over graves, and are due to the chemical changes going on in the corpse!! Reichenbach also asserts, that sleep is more sound and refreshing when the sleeper lies in the magnetic meridian; that is, with his head towards the north, and his feet to the south: and he ascribes the painful and disagreeable feelings which some persons experience in church to the circumstance that churches are built east and west; and "those in front of the altar are necessarily in the position from west to east, which, to all sensitive persons, is the most intolerable!!"

[5] *Der mineralische Magnetismus und seine Anwendung in der Heilkunst,* von C. A. Becker, M.D. Mühlhausen, 1829.

In some instances it has appeared to exercise a most remarkable influence over neuralgic pains and spasmodic affections; at one time apparently curing, at another palliating, and occasionally augmenting all the patient's sufferings. But, in a large proportion of cases, it has failed to produce any obvious effect. The employment of magnetic plates is sometimes attended with itching and an eruption of pimples.

USES.—Toothache, neuralgia, painful affections of the stomach, rheumatic pains, spasmodic asthma, angina pectoris, and palpitation of the heart, are the maladies which have occasionally appeared to be relieved by the magnet. It is said that, in some cases, neuralgic pain is alleviated by the application of the north pole of the magnet, and is augmented by the south pole.[1] Laennec[2] speaks highly of the efficacy of magnetised plates in neuralgia of the lungs, and in angina pectoris. He applied two strongly magnetised oval steel plates, one to the left precordial region, the other exactly opposite on the back, so that their poles were opposed. He says the relief is increased if a blister be applied under the anterior plate. The late Dr. Thomas Davies[3] tried this plan, and with good effect.

Mr. Smee[4] has proposed to detect the existence of needles or other steel bodies impacted in the body, by making the needle magnetic, either by the approximation of a powerful electro-magnet, or by transmitting a current of voltaic electricity along a covered copper wire coiled round the suspected part. When the needle has thus been magnetised, its presence may be detected by bringing in contact with the part containing it a delicate carefully-poised magnetic needle, by the deviations of which the existence of the foreign steel body may be recognised, and even the direction of its poles determined.

APPLICATION.—There are several modes of using magnets. For toothache, a *simple straight* or *bar magnet,* sometimes called a *magnetic staff,* is used. It is first made warm, and its north pole applied to the tooth: if the pain be not relieved, the south pole should then be substituted. Or the poles are applied to, or passed over, the gums or cheeks. In neuralgic pains, a *compound magnet,* called a *magnetic battery,* is commonly employed. This consists of several curved (horse-shoe, lyre-shaped, or U-shaped) magnets, placed one over the other with all their poles similarly disposed, and fastened firmly together. Dr. Schmidt[5] employed a battery of five magnets of unequal length, the centre one being the longest and thickest. This kind of battery is usually called by workmen a *magnetic magazine. Magnetic collars, girdles, bracelets,* &c. are made of several artificial magnets, with their opposite poles in contact, inclosed in linen or silk. *Magnetised steel plates*

---

[1] *Lancet,* 1832–33, vol. ii. p. 312.

[2] *A Treatise on the Diseases of the Chest,* translated by Dr. Forbes, pp. 402 and 693, Lond. 1827.

[3] *Lectures on the Diseases of the Lungs and Heart,* p. 497, Lond. 1835.

[4] *On the Detection of Needles and other Steel Instruments impacted in the Human Body,* Lond. 1845.

[5] *Lancet* for 1835–36, vol. i. p. 338.

(*magnetic plates*), of various forms, are fitted to any part of the body. They are applied to the naked skin, and worn by the aid of a bandage.[1]

PART III.—HYGIENIC REMEDIES.

(*Remedia hygienica.*)

These are remedies derived from the department of hygiène.

Under the absurd name of the *non-naturals* (*non-naturalia*), the ancients included six things necessary to health, but which, by accident or abuse, often became the cause of disease;—viz. *air, aliment, exercise, excretions, sleep,* and *affections of the mind.*[2] These are now denominated *hygienic agents.*[3]

I propose very briefly to consider, as therapeutic agents, *food, climate,* and *exercise.*

Affections of the mind have been already noticed (see p. 2).

1. CIBUS.—FOOD.

All the substances employed as food are compounds; and in many cases they are mechanical mixtures or chemical combinations of two or more compounds. We may, therefore, most conveniently study them under three heads, as follows:—

1. Chemical elements of food.
2. Alimentary principles.
3. Compound aliments.

1. *Chemical Elements of Food.*

Twelve simple or undecompounded substances compose the various articles used by man as food, and are called the *chemical elements* or *elementary constituents of food.* They are as follows:—

1. Carbon.
2. Hydrogen.
3. Oxygen.
4. Nitrogen.
5. Phosphorus.
6. Sulphur.
7. Iron.
8. Chlorine.
9. Sodium.
10. Calcium.
11. Potassium.
12. Magnesium.

---

[1] Figures of the different forms of magnetic instruments here referred to are given in Andry and Thouret's *Mémoire* before quoted. For further information on the subject of magnetism, as a medicinal agent, the reader is referred to the works before quoted, as well as to Dr. Bulmerincq's *Beiträge zur ärztlichen Behandlung mittelst des mineralischen Magnetismus*, Berlin, 1835; Dr. Schnitzer's *Ueber die rationelle Anwendung des mineralischen Magnetismus*, Berlin, 1837; and Dr. Most, *Encyklopädie der gesammten medicinischen und chirurgischen Praxis*, art. *Magnetismus mineralis*, 2er Band, S. 394, Leipzig, 1837.

[2] For an account of the non-naturals, consult Sutherland's *Attempts to revive Antient Medical Doctrines*, vol. ii. p. 113, Lond. 1763. Also, Willich's *Lectures on Diet and Regimen*, 3d edit. Lond. 1800.

[3] Rostan (*Dict. de Médecine*, art. *Hygiène*) terms them *Matière de l'Hygiène.* On Hygiène, consult Dr. A. Kilgour's *Lectures on the Ordinary Agents of Life as applicable to Therapeutics and Hygiène*, Edinb. 1834; Dr. Dunglison, *On the Influence of Atmosphere and Locality; Change of Air and Climate; Seasons; Food; Clothing; Bathing; Exercise; Sleep; Corporeal and Intellectual Pursuits, &c. &c. on Human Health; constituting Elements of Hygiène*, Philadelphia, 1835: Sir John Sinclair's *Code of Health and Longevity*, 4 vols. Edinb. 1807.

Carbon and *hydrogen*, by their oxidation in the system, furnish heat. Liebig estimates the amount of carbon daily consumed by an adult taking moderate exercise at $13\cdot\frac{9}{10}$ ounces Hessian ($=15\cdot\frac{3}{10}$ ounces avoirdupois);[1] a quantity sufficient to produce as much heat as will daily raise the temperature of 143 lbs. (Hessian) of water from the freezing point 32° F. to 98·5° F., the temperature of the body, besides furnishing the requisite heat for the evaporation of 48 ounces (Hessian) of water through the skin and lungs.[2]

Nitrogen is an essential constituent of all foods capable of forming blood and organised tissues. By determining the relative quantities of this element contained in nitrogenised foods, *scales of nutritive equivalents* have been formed.[3]

2. *Alimentary Principles.*

These are substances which consist of two or more chemical elements, and are constituents of the compound aliments. They are about seventeen in number:—

1. Fibrin.
2. Albumen.
3. Casein.
4. Gluten (*Beccaria's*).[4]
5. Gelatin.
6. Oil or fat.
7. Starch.
8. Sugar.
9. Gum.
10. Pectin.
11. Alcohol.
12. Citric, tartaric, acids, &c.
13. Common salt.
14. Earthy phosphates.
15. Certain ferruginous compounds.
16. Potash salts.
17. Water.

They may be arranged in two classes, as follows:—

CLASS I. ORGANIC OR CARBONACEOUS ALIMENTARY PRINCIPLES.—These principles are derived from the organic kingdom, and contain each more than one equivalent of carbon. Some of them contain nitrogen; others are devoid of this element. Hence they are divisible into two orders.

Order 1. *Nitrogenised alimentary principles.*—These serve for the formation of blood and living tissues, and have, therefore, been termed *plastic elements of nutrition*. All of them contain carbon, hydrogen, oxygen, and nitrogen; and in some of them sulphur and phosphorus are also present. They may be arranged in two groups.

a. The *albuminous alimentary principles* contain sulphur, and in some cases phosphorus also. They have a composition identical with that of the constituents of the blood; and as they serve for the formation of flesh and blood, they may be termed the *flesh-and-blood-making principles*. They contain for every equivalent of nitrogen eight equivalents of carbon. All of them yield the substance called by Mulder *protein*[5] ($=C^{40}\ H^{31}\ N^{5}\ O^{12}$); and hence they may be termed *proteinaceous* principles. The following is the composition of these principles according to Mulder:—

---

[1] Liebig's *Animal Chemistry*, edited by Wm. Gregory, M.D. 3d ed. 1846, p. 13.

[2] Liebig, *op. cit.* pp. 44–45.

[3] Boussingault, *Ann. Chim. et Phys.* t. lxiii. pp. 225–244, 1836; Schlossberger and Kemp, *Lond. Ed. and Dubl. Phil. Mag.* vol. xxvii. p. 350, 1845; Pereira, *Treatise on Food and Diet*, p. 55, 1843.

[4] Raw or common gluten of wheat, sometimes called Beccaria's gluten, is only partially soluble in alcohol. The portion dissolved is called *glutin*, and the undissolved portion is *zymome*, or *vegetable fibrin*.

[5] *Protein* so called by Mulder, from πρωτεύω, *I hold the first place*, "because it is the origin of so many dissimilar bodies, and is itself, therefore, a primary substance."

1. Fibrin		$10\ (C^{40}\ H^{31}\ N^{5}\ O^{12}) + SP$
2. Albumen	of eggs	$10\ (C^{40}\ H^{31}\ N^{5}\ O^{12}) + SP$
	of serum of the blood	$10\ (C^{40}\ H^{31}\ N^{5}\ O^{12}) + S^{2}P$
3. Casein		$10\ (C^{40}\ H^{31}\ N^{5}\ O^{12}) + S$
4. Glutin of wheat[1]		$10\ (C^{40}\ H^{31}\ N^{5}\ O^{12}) + S^{2}$

Recent investigations[2] conducted in the Giessen laboratory show that the proportion of sulphur in these organic principles has been underrated.

β. The *gelatigenous alimentary principles* do not furnish protein; but by boiling in water they yield a jelly, whence they are termed gelatinous, or more correctly gelatigenous, principles. They are not adapted by their composition for the formation of flesh and blood, but appear to serve for the reproduction of the gelatinous tissues,—such as the skin, cellular membrane, cartilage, and membrane. This division of alimentary principles includes—

1. Common gelatin or collin (gelatinous tissues and tendons)	$C^{48}\ H^{41}\ N^{7\cdot5}\ O^{18}$
2. Chondrin	$C^{48}\ H^{40}\ N^{6}\ O^{20}$
3. Gelatin of the elastic tissues (*e.g.* arterial membrane)	$C^{48}\ H^{38}\ N^{6}\ O^{16}$

The formulæ assigned to these bodies are those given by Liebig.[3] Recently Verdeil[4] has detected sulphur in chondrin and isinglass. In the latter substance, however, it appeared to be in the form of an oxygen compound.

Order 2. *Non-nitrogenised organic alimentary principles.*—These principles consist of carbon, hydrogen, and oxygen. The ultimate purpose which they serve in the animal economy is that of furnishing carbon, and in some cases hydrogen also, for the support of the function of respiration, and consequently for the production of animal heat: hence they are termed *elements of respiration.* Some of them contribute to the formation of fat,[5] while others appear to serve some other but not very obvious purposes in the animal economy.

The non-nitrogenised alimentary principles may be conveniently arranged in three groups thus—

a. Non-nitrogenised alimentary principles whose oxygen and hydrogen are in the same ratio as in water.—This order contains starch, gum, sugar, and acetic acid.

1. Acetic acid (dry)	$= C^{12}\ H^{9}\ O^{9}$
2. Starch	$= C^{12}\ H^{10}\ O^{10}$
3. Cane sugar (crystallised)	$= C^{12}\ H^{11}\ O^{11}$
4. Gum	$= C^{12}\ H^{11}\ O^{11}$
5. Sugar of milk (crystallised)	$= C^{12}\ H^{12}\ O^{12}$
6. Grape sugar (crystallised)	$= C^{12}\ H^{14}\ O^{14}$

Starch by digestion is converted into sugar. Both starch and sugar, when taken as food, contribute to the formation of fat.[6] Gum, though closely related by composition to both starch and sugar, differs from both of them in several particulars. Unlike starch, it does not appear to be convertible into sugar; and it differs from sugar in not being resolvable into alcohol and carbonic acid by fermentation.

---

[1] "By *glutin*, I mean the substance which can be extracted by alcohol from Beccaria's gluten."—(*Mulder*).

[2] Rüling, Walther, and Verdeil, in the *Annalen der Chemie und Pharmacie*, Bd. lviii. 1846.

[3] *Animal Chemistry*, p. 126, 1842.

[4] *Ann. d. Chem. u. Pharm.* Bd. lviii. S. 320–322, 1846.

[5] On the fatty nature of the nucleoli of cells, and on the use of fatty matter in growth and nutrition, healthy and diseased, see Gulliver, in *The Works of Hewson*, published by the Sydenham Society, 1846, footnote, p. 88.

[6] At present butyric acid is the only fatty acid which has been artificially produced from sugar.

β. *Non-nitrogenised alimentary principles whose oxygen is to the hydrogen in a less proportion than in water, or which contain an excess of hydrogen.*—These substances furnish hydrogen as well as carbon for the function of respiration:—

1. Alcohol.. = $C^4 H^6 O^2$
2. Fat (hydrated oleic acid).................................... = $C^{36} H^{34} O^4$

Various facts concur in proving that alcohol, when employed moderately, disappears wholly or partially from the organism; and we conclude that its carbon and hydrogen become oxidized, and are given out in the form of carbonic acid and water. Alcohol, therefore, must be an element of respiration. When alcohol is used immoderately, part of it is always thrown out of the system as alcohol.

Oily or fatty substances used as food supply fat to the system, and contribute to support the function of respiration.

γ. *Non-nitrogenised alimentary principles whose oxygen is to the hydrogen in a proportion greater than is necessary to form water.*—In this order we have the following substances:—

1. Pectin .... = $C^{12} H^{8\cdot5} O^{11}$
2. Citric acid (dry) .... = $C^{12} H^5 O^{11}$
3. Tartaric acid (dry) .... = $C^8 H^4 O^{10}$
4. Malic acid (dry) .... = $C^8 H^4 O^8$

Although all these agents ultimately act as elements of respiration, yet some of them appear to serve some other important but not very obvious use in the animal economy; since the employment of the acids or their salts, as found in succulent vegetables and fruits, appears necessary for the preservation of health; complete and prolonged abstinence from them being a cause of scurvy.

CLASS II. INORGANIC OR NON-CARBONACEOUS ALIMENTARY PRINCIPLES.—Water, iron (in some state of combination), earthy phosphates, chloride of sodium, and other alkaline salts, are the inorganic constituents of the body. Of these, water and chloride of sodium are alone used in the uncombined state as aliments: the other ingredients are obtained in combination with organic alimentary substances.

3. *Compound Aliments.*

These are mechanical mixtures or chemical combinations of two or more alimentary principles. They are either solid or liquid, the latter being termed drinks. Those which are employed at the table for flavouring or seasoning are called condiments. We may, therefore, conveniently consider them under three heads—

1. Solid foods.
2. Liquid foods or drinks.
3. Condiments or seasoning agents.

1. SOLID FOODS.—Man derives his food from both animals and vegetables. We may, therefore, conveniently divide compound foods into animal and vegetable.

a. Animal Foods.—These are obtained from various classes of animals. Those in common use in this country are as follows:—

Mammalia: The ox, sheep, deer, hog, hare, rabbit, &c.
Aves: The common fowl, pigeon, pheasant, partridge, turkey, goose, duck, &c.
Reptilia: The green or edible turtle.
Pisces: Mackarel, salmon, herring, sprat, white bait, cod, haddock, flat fish, eel, &c.
Mollusca: The oyster, mussel, cockle, scallop, periwinkle, limpet, and whelk.
Crustacea: The lobster, crab, prawn, and shrimp.

The parts of animals used are the ***flesh, blood, viscera, bones, cartilages, ligaments, cellular tissue,*** and ***eggs.***

The alimentary principles, exclusive of ***water*** and ***saline matters,*** derived from solid animal foods, are ***fibrin, albumen, casein, gelatin,*** and ***fat.*** The relative proportions of water, fibrin or albumen, and gelatin, in the flesh of various animals, are thus stated by Mr. Brande:[1]—

Composition of Flesh.

100 *Parts of Muscle.*	*Water.*	*Albumen or Fibrin.*	*Gelatin.*	*Total of Nutritive Matter.*
Beef	74	20	6	26
Veal	75	19	6	25
Mutton	71	22	7	29
Pork	76	19	5	24
Chicken	73	20	7	27
Cod	79	14	7	21
Haddock	82	13	5	18
Sole	79	15	6	21

β. Vegetable Foods.—These are derived from a great number of natural orders. Those in most frequent use are as follows:—

Exogens or Dicotyledons.

1. *Cruciferæ:* Cabbage, turnip, and mustard.
2. *Byttneriaceæ:* Cocoa.
3. *Ternstrœmiaceæ:* Tea.
4. *Aurantiaceæ:* Orange and lemon.
5. *Ampelideæ:* Grape.
6. *Leguminosæ:* Peas and beans.
7. *Rosaceæ:* Strawberry and raspberry.
8. *Amygdaleæ:* Almond, plum, peach, and cherry.
9. *Pomaceæ:* Apple and pear.
10. *Cucurbitaceæ:* Cucumber and melon.
11. *Umbelliferæ:* Carrot and parsnip.
12. *Compositæ:* Artichoke, lettuce, and endive.
13. *Oleaceæ:* Olive.
14. *Solanaceæ:* Potato.
15. *Chenopodiaceæ:* Spinage and beet.
16. *Polygonaceæ:* Rhubarb.
17. *Euphorbiaceæ:* Tapioca.
18. *Urticaceæ:* Figs and mulberries.
19. *Amentaceæ:* Chesnut and hazelnut.
20. *Juglandaceæ:* Walnuts.

Endogens or Monocotyledons.

21. *Marantaceæ:* Arrow-root and tous les mois.
22. *Bromeliaceæ:* Pine apple.
23. *Liliaceæ:* Onion, leek, and asparagus.
24. *Palmaceæ:* Cocoa nut, sago, and date.
25. *Gramineæ:* Cereal grains or corn, and sugar cane.

Cryptogamia.

26. *Lichenes:* Iceland moss.
27. *Algæ:* Laver, carrageen, Ceylon moss.
28. *Fungi:* Common mushroom, morell, and truffle.

The parts of plants used as food are the ***seeds*** (embryo and albumen), ***fleshy pericarps, leaves and petioles, buds and young shoots, stems, tubers,*** and ***roots.***

The ***seeds*** are of two kinds: farinaceous and oleaginous. The ***farinaceous seeds*** used as food are corn, peas, beans, lentils, and the chesnut. The *oleaginous seeds* are the walnut, hazel and filbert nut, cocoa nut, cashew nut, pistachio nut, and stone pine nut.

---

[1] *Manual of Chemistry.*

The alimentary principles, exclusive of *water* and *saline principles*, derived from plants, are *fibrin, albumen, casein, gluten, oil, sugar, starch, gum, pectin*, and certain *organic acids*.

Corn or the cereal grains, the most important of all vegetable foods, consist of *starch, fibrin, albumen, gluten, mucine, oily matter, sugar, gum, earthy phosphates, ligneous matter*, and *water*.

The relative proportions of water, starch, gluten, albumen, &c. in corn and some other vegetable foods, are as follows :[1]—

CORN AND OTHER VEGETABLE FOODS.	*Water.*	ANHYDROUS SUBSTANCES.		
		Starch.		*Gluten, Albumen.*
		I.	II.	
	Per cent.	Per cent.	Per cent.	Per cent.
Wheat flour, No. 1, from Vienna	13·828	65·21	66·16	19·16
" No. 2, "	16·650	66·93	57·80	13·54
" No. 3, "	12·731	57·70	57·21	21·97
Talavara wheat, from Hohenheim	15·432	55·92	56·59	16·54
Sandomir wheat " "	15·480	53·83	52·92	17·18
Whittington wheat " "	13·930	53·06	51·84	17·11
Rye flour, No. 1, from Vienna	13·780	61·62	60·56	11·94
" No. 2, "	14·680	54·84	54·12	18·71
" from Darmstadt	13·660	57·07	57·77	......
Rye (*Secale cereale*, winter corn), from Hohenheim...	13·940	45·39	44·80	17·75
" (*Secale cereale arundinaceum*) " " ...	13·820	47·71	47·13	15·77
White oats (*Avena sativa*) " " ...	12·940	37·93	36·90	18·00
Kamtschatka oats (*Avena sativa*) " " ...	12·710	39·55	40·17	15·26
Barley flour, from Darmstadt	12·560	64·63	64·18	......
Jerusalem barley (*Hordeum distichon*), from Hohenheim	16·970	42·66	42·03	14·74
Barley (*Hordeum vulgare*), from Hohenheim	13·800	38·62	37·99	17·81
Maize, from Hohenheim	14·960	65·88	66·80	14·68
Maize flour "	13·359	77·74	......	13·66
Buckwheat flour, from Vienna	15·120	65·05	......	6·89
Tartarian buckwheat (*Polygonum tartaricum*), Hohenh.	14·120	43·80	44·45	9·96
One-grained wheat (*Triticum monococcum*), from Giessen	14·400	55·51	53·76	13·22
Rice, from Giessen	15·140	85·78	86·63	7·40
Beans, from Vienna	13·415	37·71	37·79	28·54
Peas "	13·430	38·81	38·70	28·22
Lentils (*Ervum Lens*), from Giessen	13·110	39·62	40·08	......
100 *Parts of the Air-dry Substances contained in their usual condition*—				
Potatoes, No. 1 (blue), from Giessen	68·94	23·20	22·80	2·37
" No. 2 (white), "	74·95	18·14	17·98	2·49
" No. 3	76·80	15·48	16·09	......
		Cane Sugar.		
Beet-root	81·61	10·20	10·48	2·03
Mangel-wurzel	82·25	12·22	12·31	2·04

2. LIQUID FOOD OR DRINKS.—These may be arranged under six heads as follows :—

---

[1] Krocker, in *Pharmaceutical Journal*, Feb. 1847.

1. Mucilaginous, farinaceous, or saccharine drinks; as toast water, gruel, mucilage, &c.
2. Aromatic or astringent drinks; as tea, coffee, chicory, cocoa, and chocolate.
3. Acidulous drinks; as lemonade, ginger beer, &c.
4. Animal broths; as beef tea, mutton broth, &c.
5. Emulsive or milky drinks; as milk.
6. Alcoholic drinks; as beer, wine, and ardent spirit.

3. CONDIMENTS OR SEASONING AGENTS.—Most of the agents under this name are themselves more or less alimentary, and, therefore, serve some more important purposes than that of merely gratifying the appetite.

The substances usually denominated condimentary may be arranged in five classes as follows:—

1. Saline condiments.
2. Acidulous condiments.
3. Oily condiments.
4. Saccharine condiments.
5. Aromatic and pungent condiments.

Salt, vegetable acids, oils and fats, and sugar, are in fact alimentary principles, and have been before noticed. The aromatic and pungent condiments owe their peculiar properties to volatile oil or resin, and are devoid of nutritious properties.

2. EXERCITATIO.—EXERCISE.

(*Gymnastics.*)

Exercise is an important hygienic agent; but its proper consideration requires far more space than can be devoted to it in this work. I must, therefore, content myself with a few remarks on its general effects, and refer the reader to other works in which it is more fully considered.

Though the word exercise, in its most extensive signification, has reference to the action of all the organs of the animal economy, yet it is usually limited to those of locomotion; and in this sense I employ it.

The exercise of the muscular system is followed by several effects, which may be conveniently arranged under four heads; viz.—

1. Mechanical effects.
2. Organic or vital effects.
3. Nervous effects.
4. Mental effects.

1. *Mechanical Effects.*—Whenever the muscles are called into activity, they exert a local influence, of a mechanical kind, on the blood-vessels in their immediate vicinity, and thereby accelerate the circulation of the blood. This is followed by an augmentation of the animal heat; and, if the exercise be of a kind to call into activity a considerable number of muscles, the general circulation soon participates in the effects; the pulse is quickened, and the respiration and secretions are augmented. Another effect, which, in its origin, is probably of a mechanical nature, is the absorption of the fat between the muscles and their fasciculi, and which seems to arise from the pressure exerted by the contracted muscle on the soft tissues immediately around it.

2. *Organic or Vital Effects.*—This includes the augmentation of volume, of firmness, of elasticity, and of strength or power, which a muscle acquires

from frequent but moderate use. Blacksmiths, fencers, and prize-fighters, furnish excellent illustrative examples of these effects.

3. *Nervous Effects.*—The action of the muscles can only be effected through the medium of the nervous centres and nerves: the latter, therefore, are called into activity, and through them the whole system becomes influenced by the exercise of a number of muscles.

4. *Psychical or Mental Effects.*—To this head belong the different mental effects produced by agreeable and disagreeable,—by voluntary and compulsory,—exercises. Employed moderately, agreeable exercise acts as a salutary excitant to the intellectual faculties and sensations. I agree with the late Dr. James Johnson,[1] "that travelling exercise, while it so much improves all the bodily functions, unhinges and unfits the mind, *pro tempore*, for the vigorous exercise of its higher faculties." But the first excitement being over, "the memory of scenes and circumstances, together with the reflections and recollections attendant thereon, furnish an ardent mind with rich materials and trains of thought, that may, by gifted individuals, be converted into language; and thus conveyed to thousands."

Thus, then, exercise, employed moderately, has a tonic and stimulating influence on the system, and is calculated to be beneficial in a great variety of complaints. Used immoderately, it exhausts both the mental and bodily powers, and produces great debility. In fever, in vascular excitement or inflammation of the brain, in inflammatory affections of the lungs, in maladies of the circulating organs (especially dilatation of the cavities of the heart, diseased valves, and aneurism), in violent hemorrhages, gastro-enteritic inflammation, acute rheumatism, &c. muscular exertion is manifestly injurious; repose and inaction being indicated. In sprains and lacerations of the muscles, in fractures and dislocations, &c. it is obviously improper. In hernia, or a tendency thereto, great muscular exertion must be carefully avoided.

Exercises may be divided into the *active*, the *passive*, and the *mixed*. To the first belong walking, running, leaping, dancing, fencing, wrestling, &c.; to the second are referred, carriage exercise and sailing; while horse exercise belongs to the third or last division.[2]

An important part of the treatment of distortions of the spine which are unconnected with caries, consists in the employment of particular exercises contrived with the view of strengthening the muscles of the back. "All climbing exercises," says Sir B. Brodie,[3] "are useful in this respect, bringing all the muscles of the spine into vigorous action. They are at the same time beneficial in another way, the weight of the lower limbs tending to elongate and strengthen the column of the vertebræ. A rope, with worsted wound round it, that it may not hurt the hands, may be suspended from the ceiling, and the patient will soon become a dexterous climber. There are often two or three girls in a family for whom this exercise will be beneficial; and that which would be a tedious and irksome task to a girl alone, will become an amusement when pursued in the company of others of her own age. The handswing affords a very useful exercise in these cases also. This is a triangle composed of a double rope, with a cross-bar of wood forming the base of the triangle, suspended from the ceiling at such a height that the individual who uses it can just reach the cross-bar with her hands as she stands on tip-toe. She is to hold the bar with both her hands, and swing with her feet raised a little from the ground. The effect of this exercise also is to bring the muscles of the spine into action, at the same time that the weight of the lower limbs operates in the same manner as when she climbs a rope. At first probably she will not be able to continue to use the handswing for more than a few seconds at a time; but as she grows stronger she will swing for a much longer period. Another mode of exercising, and thus strengthening the muscles of the back, is the following:—Let one pulley be fixed to the ceiling, and another to the floor. Let a small rope pass over the upper pulley and under the lower pulley, a box containing a light weight being fastened to that end of the rope which is nearest to the upper pulley, and a handle to that which is nearest to the lower pulley. The patient, standing with her face towards the pulleys, is to raise and lower the weight, holding the handle in both her hands. The effort used in raising the weight necessarily calls the muscles of the back into action; and as the patient becomes accustomed to it, the required effort may be increased by putting an additional weight into the box. This exercise may be varied by taking off the handle and fixing the rope to a bandage fastened round the head, so that the weight is raised by the action of the muscles of the neck and back without the aid of the arms. The latter method of using the pulleys, however, is wearisome to the patient, and practically much less useful than the other."

---

[1] *Change of Air, or the Pursuit of Health and Recreation*, 4th edit. 1838.

[2] For further information on the subject of Exercise, the reader is referred to Celsus, lib. i. cap. 2, and lib. ii. cap. 15; Sir J. Sinclair's *Code of Health and Activity*, Edinb. 1807; Dunglison's *Elements of Hygiène*, Philadelphia, 1835; *Dict. de Médecine*, art. *Gymnastique*; *Dict. de Médecine et de Chirurgie pratiques*, art. *Gymnastique*; *Manuel d'Education physique, gymnastique et morale*, par le Colonel Amoros, Paris, 1830.

[3] *Lond. Medical Gazette*, Jan. 1, 1847.

3. CLIMA.—CLIMATE.

Under the word Climate are included those topographical, atmospheric, and other conditions of a region or country, which have a beneficial or injurious influence on the health and lives of the inhabitants.[1]

I shall briefly notice the subject under three heads.

1. Phenomena of climates.
2. Climates most frequently used as therapeutical agents.
3. Diseases for which change of climate is employed.

1. PHENOMENA OF CLIMATES.

It is probable that we are yet ignorant of many circumstances which contribute to produce the climatic character of a place; and, of those that are known, it is often not easy to define the separate influence of each.

The most obvious circumstances which affect the climate of a region or country, are *temperature, humidity, purity of the atmosphere, wind,*

---

[1] Dr. Shirley Palmer, in his *Pentaglot Dictionary*, defines climate as "an extent of country wherein all the circumstances which exercise an influence upon organised beings are nearly the same. Again, the assemblage of all these circumstances and conditions, exclusive of organic texture, on which life depends, and which exert upon it a perceptible operation."

atmospheric pressure, intensity of light, atmospheric equability or *vicissitudes, soil, amount of vegetation,* and *proximity to the sea.*

[In the above remark, "It is probable that we are yet ignorant of many circumstances which contribute to produce the climatic character of a place," we trace the dissatisfaction which the inquisitive and powerful mind of the late talented author felt with the state of our knowledge as respects the therapeutical uses of climate. Late discoveries have suggested much since the last edition of this work was published, but sufficient time has not yet been given to obtain useful results. We refer especially to the observations on ozone[1] by Professor Schönbein, and others, which have proved that atmospheric conditions must in future be regarded in relation to the presence, absence, or proportion of this element as an important part (if, indeed, not the *most* important), of the history of climates.—ED.]

1. TEMPERATURE.—In considering the temperature of a place, we must regard, not merely its annual mean, but its extremes. Inland tracts of country experience greater extremes than the coasts, in consequence of the land being more rapidly heated and cooled than water. Hence it attains a higher temperature in summer, and a lower one in the winter. It is also deserving of notice that the western coasts of the extra-tropical continents have a much higher mean temperature than the eastern coasts. This is explained by the heat evolved in the condensation of vapour swept from the surface of the ocean by the western winds.[2] The effects of heat and cold on the human body have been already considered.[3] Liebig ascribes the frequency of diseases of the liver in hotseasons and tropical climates to the accumulation of carbon in the system. This he thinks arises from the consumption of too much food; and from the inspiration of a smaller quantity, by weight, of oxygen than in cold climates and cold seasons, in consequence of the air being expanded by the heat. *Warm climates* are adapted for pulmonary invalids (especially consumptive patients), the rheumatic, the scrofulous, the paralytic, and those who suffer from the effects of a feeble circulation. *Cold*, or rather *moderately cool*, climates are bracing, and fitted for relaxed constitutions. Cold weather and cold climates are injurious to the aged, the paralytic, the phthisical, the scrofulous, the diabetic, and the rheumatic.

2. HUMIDITY. *Hygrometric State of the Atmosphere.*—Evaporation from the cutaneous and pulmonary surfaces is augmented by a dry, and checked by a damp or moist, state of the atmosphere. But the transudation which depends on vital action is augmented by warmth and moisture.[4] "Of all the physical qualities of the air," observes Sir James Clark,[5] "humidity is the most injurious to human life." Intermittents and even phthisis have been ascribed to it.[6] A *moist* climate checks evaporation; and, therefore, a *soft* climate is adapted for chronic bronchitis of a dry irritable kind, frequently denominated dry catarrh, and for some other maladies attended with a harsh, dry, parched skin. A *dry* climate, on the other hand, promotes evaporation, and, therefore, is better fitted for relaxed, languid constitutions, with profuse secretion and exhalation; as humid asthma, and those forms of chronic catarrh which are accompanied with copious expectoration.

As aqueous vapour is the chief fluctuating ingredient of the atmosphere, it is probable that to its varying quantities must be ascribed many of those feelings and conditions of the body popularly referred to the weather. "There are days," says the late Professor Daniell,[7] "on which even the most robust feel an oppression and languor, which are commonly and justly attributed to the weather; while on others they experience exhilaration of spirits, and an accession of muscular energy. The oppressive effect of close weather and sultry days may probably be accounted for from the obstruction of the insensible perspiration of the body, which is prevented from exhaling itself into the atmosphere, already surcharged with moisture; while unimpeded transpiration from the pores, while the air is more free from aqueous vapour, adds new energy to all the vital functions. In bodies debilitated by disease, indeed, the contrary effects may be produced: they may be unable, from weakness, to support the drain of free exhalation which is exhilarating to the healthy; and hence probably arises the benefit of warm sea breezes in cases of consumption and diseases of the lungs."

---

[1] See article *Oxygen.*

[2] Daniell's *Meteorological Essays*, p. 105, 2d edit. Lond. 1827.

[3] See pp. 12, 13, 23, et seq.

[4] Edwards, *De l'Influence des Agens Physiques*, p. 338, Paris, 1824.

[5] *The Sanative Influence of Climate*, 3d ed. Lond. 1841.

[6] Forcault, *Causes générales des Maladies chroniques, spécialement de la Phthisie Pulmonaire, et Moyens de prévenir le Développement de ces Affections*, Paris, 1844.

[7] *Elements of Meteorology*, vol. ii. p. 310, Lond. 1845.

3. PURITY OF THE ATMOSPHERE.—A pure condition of the atmosphere is an essential element of all healthy climates. The greater mortality of cities than of the country is principally referable to the respiration of air vitiated by the congregation of a large number of persons in a comparatively limited space. Air contaminated by the exhalations or effluvia from wet lands, swamps, marshes,[1] animal and vegetable substances in a state of decomposition,[2] and human bodies, especially those of the sick, is a prolific cause of disease. The aëriform poison thus introduced into the atmosphere is called *miasma* (*μίασμα*, a stain or pollution), or *malaria* (an Italian word, derived from *mala*, bad, and *aria*, air). Its chemical nature is unknown. Gaseous exhalations from the earth in volcanic and other districts form another source of local atmospheric impurity;[3] and to those must be added the vapour, smoke, or fumes from various chemical works.[4] The injurious effect of fogs on asthmatic patients is well known to every one. Curiously enough, however, some patients affected with spasmodic asthma breathe better in a smoky atmosphere (as that of London) than in pure air.

4. WIND.—Wind greatly modifies the effect of temperature on the body. Thus two successive days, whose temperature, as indicated by the thermometer, may be the same, shall produce in us—the one a sensation of warmth, in consequence of the calm, still, condition of the air; while the other creates a feeling of cold, from the presence of a violent wind. So that, as Sir James Clark[5] has justly observed, "the influence of temperature on the living body is indicated much more accurately by our sensation than by the thermometer." Moreover, the humidity and the purity of the atmosphere are greatly modified by the motion or calmness of the air. The precise effects produced on climates by wind must of course depend on its direction, violence, &c. "Common experience has proved that in all countries the winds which have blown over large tracts of land are much drier than those which proceed from the sea."[6]

5. ATMOSPHERIC PRESSURE.—The total amount of atmospheric pressure on a man of

---

[1] The production of Ague, by the exhalations from stagnant water and marshy soils, is well known to every one.

[2] The late Professor Daniell (*Lond. Edinb. and Dubl. Phil. Mag.* July 1841,) found in sea water brought from the Western coast of Africa sulphuretted hydrogen; and he suggested that the existence of this deleterious gas in the atmosphere, which must necessarily accompany its solution in the waters, may be connected with the awful miasma which proves so fatal to the explorers and settlers of the deadly shores of Africa, as well as of other places. But the gas which he obtained from these waters must have been developed after they were bottled; for neither in the river nor sea water, when fresh collected, can a trace of sulphuretted hydrogen be detected. (See Dr. M'William's *Medical History of the Expedition to the Niger during the years* 1841–2, Lond. 1843, pp. 160–175 and 190–193; also Dr. Pritchett's *Account of the African Remittent Fever*, Lond. 1843, pp. 117–118).

The origin of sulphuretted hydrogen in sea and some other waters has been ascribed, by Dr. Marcet (*Phil. Trans.* 1819, p. 195), Mr. Malcomson (*Trans. of the Geological Society*, 2d Ser. vol. v. p. 564, Lond. 1840), Dr. A. Fontan (*Ann. de Chem. et de Phys.* July 1840), and Professor Daniell (*op. supra cit.*), to the decomposition of the sulphates of the waters by putrifying vegetable matter.

[3] *Carburetted hydrogen* (CH^2) issues from coal strata, and is also evolved from the earth in other situations where there is no reason to suspect the presence of coal. *Carbonic acid gas* (CO^2) is abundantly set free in volcanic and other districts. To this gas the Guevo Upas or Valley of Poison in Java (*Journal of Geographical Society*, vol. ii.), and the Grotto del Cane (*Med. and Phys. Journ.* Oct. 1832), owe their remarkable properties. It has been calculated that 219,000,000 lbs. or about 1,855,000,000 cubic feet of carbonic acid are exhaled annually in the vicinity of the Lake of Laach (De la Beche, *Theoretical Geology*).

[4] See the articles *Arsenious Acid* and *Hydrochloric Acid.*

[5] *Op. supra cit.* p. 156.

[6] Daniell, *op. cit.* vol. i. p. 215.

ordinary stature may be estimated at about 30,000 lbs.; and a fall of half an inch in the column of mercury in the barometer is equivalent to a reduction of about 500lbs. atmospheric pressure on the body. Now it can scarcely be doubted that variations of atmospheric pressure must exert some influence over the functions of healthy, but especially of diseased, persons. It is difficult, however, to estimate, separately from other co-existent influences, the precise effects which result from these variations. Diminished atmospheric pressure promotes evaporation; and hence this is one reason why elevated regions, which are colder, drier, and more bracing than low situations, are, *cæteris paribus*, better adapted for relaxed individuals, with profuse secretion and exhalation, than the last-mentioned localities; but, on the other hand, they are injurious in bronchial or tracheal irritation, with diminished secretion.

A fall in the barometer is generally produced by an augmentation of aqueous vapour in the atmosphere; and the deposition of moisture[1] which ensues is attended with the evolution of heat. These atmospheric conditions have a powerful influence over the animal economy; for, in consequence of the diminished atmospheric pressure, the superficial vessels become gorged, and secretion is readily effected; while, from the humid condition of the air, evaporation does not take place. Hence arise a feeling of languor and fatigue, and sweating on the slightest exertion. In bronchitis, with profuse secretion, the patient's danger is greatly aggravated by diminished atmospheric pressure indicated by a sudden fall in the barometer, and by the accompanying augmented humidity of the air.

6. Intensity of Light.—The influence of light has been already considered (see page 7).

7. Atmospheric Equability or Vicissitudes.—Rapid atmospheric changes are always injurious to health, and, therefore, climates which are subject to sudden changes of temperature, or of humidity, or of atmospheric pressure, or of wind, are invariably unhealthy. Invalids, and those with delicate constitutions, often appreciate the slightest alterations in the condition of the atmosphere, and which are not observable by the healthy and the robust.

8. Soil.—The climate of a place is also greatly modified by the quality of the soil. Sandy and gravelly soils allow the rain to percolate rapidly through them, and are, therefore, called *dry soils*. Chalky soils are also called dry, though they are less so than the preceding. Sandy, gravelly, and chalky soils are in general most salubrious. They are peculiarly fitted for relaxed constitutions with profuse secretions. Clayey soils are called *wet soils*, because they retain the rain on their surface. They are in general less salubrious than the preceding, and often are positively injurious to health. They prove most obnoxious to relaxed and rheumatic constitutions. Marshy and swampy soils are most injurious to health, and have been already noticed as sources of malaria.

Soils also deserve to be considered with reference to the greater or less rapidity with which they become heated or cooled. Sir H. Davy[2] observes, that stiff white clay soils, as well as chalky soils, are with difficulty heated by the sun; while the black, dark coloured, and carbonaceous soils are much more rapidly heated.

9. Amount of Vegetation.—The character of a climate is often affected by the exuberance or deficiency of vegetation. Jungles, woods, and forests, protect the earth from the action of the solar rays, and are, in consequence, often the residence of moisture and decaying vegetation analogous to a marsh.[3]

10. Inland and Maritime Localities.—In general, the climate of places on the sea shore is more humid than that of inland localities; but to this statement there are many exceptions. (See also *Temperature*).

These are some only of the circumstances which affect the quality or character of a climate. Others doubtless exist; but their precise nature and influence have scarcely been ascertained. For example, we have yet to learn the influence of Electricity and Magnetism on the climate of a place.

---

[1] In extra-tropical climates, a fall in the barometer, without a change or rise of wind, is usually followed by rain.

[2] *Elements of Agricultural Chemistry.*

[3] Macculloch, *Malaria*, Lond. 1827.

2. Climates most frequently used as Therapeutical Agents.

I propose, now, to glance at the characters of those climates most commonly resorted to by invalids for therapeutical purposes. In doing so, I have to acknowledge the great assistance which I have received from Sir James Clark's valuable work on *The Sanative Influence of Climate,* to which I must refer the reader for further details.

Climates may, for the purpose just mentioned, be conveniently arranged as follows:—

1. Climates of England.
2. Climates of France.
3. Climates of Spain and Portugal.
4. Climates of Italy and the Mediterranean.
5. Climates of the Atlantic.

1. *Climates of England.*

"The British Islands are situated in such a manner as to be subject to all the circumstances which can possibly be supposed to render a climate irregular and variable. Placed nearly in the centre of the temperate zone, where the range of temperature is very great, their atmosphere is subject, on one side, to the impressions of the largest continent of the world; and, on the other, to those of the vast Atlantic Ocean. Upon their coasts the great stream of aqueous vapours, perpetually rising from the western waters, first receives the influence of the land, whence emanate those condensations and expansions which deflect and reverse the grand system of equipoised currents. They are also within the reach of the frigorific effects of the immense barriers and fields of ice, which, when the shifting position of the sun advances the tropical climate towards the northern pole, counteract its energy, and present a condensing surface of immense extent to the increasing elasticity of the aqueous atmosphere."[1]

Sir James Clark thus arranges the climate of England:—

1. London.
2. The South Coast.
3. South-west Coast.
4. Cornwall, Land's End.
5. West of England.

1. London.—The mean annual temperature of London is about 50°·4.[2] It somewhat exceeds that of the suburban parts. The following is an abstract of the averages of seventeen years' meteorological observations (from 1826 to 1842) made in the garden of the Horticultural Society at Chiswick, about six miles west of London:—

Temperature.	Fah.	*Dew Point.*	Fah.
Mean in the shade	49°·94	Mean	47°·36
Maximum in the shade	94°·4	Maximum	79°
Maximum in the sun	130°	Minimum	0°
Minimum in the shade	—4°·5		
Minimum radiation	—12°·0		

Barometer.	Inches.	*Rain.*	Inches.
Mean	29·931	Mean	24·16
Highest	30·856	Maximum	30·97
Lowest	28·597	Minimum	18·87

---

[1] Daniell's *Meteorological Essays*, p. 114, 2d ed. 1827.

[2] *Elements of Meteorology*, vol. i. p. 141.

Wind.

Average Number of Days in the Year during which each Wind prevails.

	N.	NE.	E.	SE.	S.	SW.	W.	NW.
Mean	24·4	47·2	37·1	21·8	56·8	79·8	65·8	31·7
Maximum	38	75	56·	38	77	126·	90	61
Minimum	17	30	17	11	38	58	46	18

"The excess of the temperature of the city varies through the year, being least in spring, and greatest in winter; and it belongs, in strictness, to the nights, which average 3°·7 warmer than in the country; while the heat of the day, owing, without doubt, to the interception of a portion of the solar rays by a constant veil of smoke, falls, on a mean of years, about a third of a degree short of that in the open plain.[1]" Hence, in the winter, delicate invalids sometimes experience benefit in coming to London from the country. But the impure state of the atmosphere frequently counterbalances these good qualities.[2] In some cases of spasmodic asthma, however, respiration is easier in London than in the country.

2. SOUTH COAST.—This comprehends the tract of coast between Hastings and Portland Island. Its mean annual temperature is about that of London; but the summers are somewhat cooler, and the winters somewhat warmer, than the corresponding seasons of the metropolis.[3] Its light is very intense. For invalids, the superiority of the climate of the South Coast over that of the metropolis is greatest during December, January, and February.

The principal places of resort for invalids, on this line of coast, are the following:—

α. *Hastings.*—A mild winter residence; placed low, and well protected from the northerly winds; but fully exposed to winds from the south. Sir James Clark[4] regards its climate "as somewhat intermediate between that of Devonshire and Clifton; less warm, but also less relaxing than the former. It is about the same temperature; but less dry and bracing than the latter, and it is inferior to it as a spring climate." It is well adapted for pulmonary invalids, who desire to avoid the north-east winds, during the months of December, January, and February (especially the two latter months). The distinguished author above quoted declares that it "is unfavourable in nervous complaints, more especially in nervous headaches connected with, or entirely dependent upon, an irritated condition of the digestive organs, and also in cases where a disposition to apoplexy or epilepsy has been manifested." With the exception of St. Leonard's, Hastings has an atmosphere more completely marine than almost any other part of this coast. Hastings has appeared to me unfavourable to rheumatic constitutions.

St. Leonard's is about a mile from Hastings, and possesses a similar climate.

β. *Brighton.*—The air is dry and bracing; and the soil dry. That part of the town east of the New Steyne is considerably elevated above the sea, has a dry chalky soil, in a pre-eminent degree possesses a dry, sharp, bracing air, and is best adapted for relaxed constitutions. That part of the town west of Cannon Place has a clayey soil, and a milder and softer air; and, according to Mr. Wigan,[1] includes the most salubrious portion of the town. It is better suited for delicate nervous invalids than the other parts. The central portion of the town is low and somewhat misty, and possesses the usual annoyances of a district placed in the midst of a large town. The Steyne has a climate intermediate between that of the eastern and western portions. The climate of Brighton is most beneficial during autumn and the early part of winter, when it is milder and more steady than that of Hastings. From the middle of March to the middle of May, Mr. Wigan advises invalids to stay away altogether from Brighton. It is adapted for relaxed individuals, with copious secretion and exhalation. It usually agrees well with children (especially those of a scrofulous habit) and convalescents. Brighton is not adapted for persons affected with congestive diseases of the venous system, inflammatory dyspepsia, or renal diseases, except, according to Mr. Wigan, albuminuria. Brighton is entirely free from marshy and swampy grounds, and is remarkably devoid of trees.

---

[1] See Luke Howard's *Climate of London*, 1818–20, 2d ed. 1833.

[2] For further details respecting the Climate of London, consult Professor Daniell's *Essay* on this subject. Also, Dr. Bateman's *Reports of the Diseases of London*, Lond. 1819; and Sir A. Carlisle, *Medical Topography of London*, in his *Practical Observations*, Lond. 1838.

[3] For the character of this part of England, consult Dr. Harwood's *Curative Influence of the Southern Coast of England, especially that of Hastings; with Observations on Diseases for which a Residence on the Coast is most beneficial*, Lond. 1828. Also, Dr. Mackness's *Hastings considered as a Resort for Invalids.*

[4] *Op. supra cit.* p. 177.

γ. *Isle of Wight.*—Undercliff presents an agreeable, mild, equable, sheltered, dry, bracing climate, well adapted for the residence of pulmonary and other delicate invalids throughout the year. It is well protected from the north winds, and has a dry soil. It differs from the climate of Torquay (which is soft, humid, and relaxing), by its dry and bracing qualities, and its greater equability of temperature. Hence it is suited for relaxed constitutions, with copious secretion. For pulmonary invalids, the best season to reside at Undercliff is from November to May; and at Ventnor will be found good accommodations for the sick.—Cowes and Ryde, on the opposite side of the island, are delightful summer residences.

δ. *Southampton.*—This part of the coast is objectionable, on account of its temperature being equally variable with that of the environs of London.

3. SOUTH-WEST COAST. *South Coast of Devon.*[2]—This comprehends the tract of coast extending from Portland Island to Cornwall. Its general qualities are those of a mild, soft, humid climate, soothing but somewhat relaxing. It "has a winter temperature nearly two degrees higher than that of the coast of Sussex and Hampshire, and from three to four higher than that of London. The difference is most remarkable during the months of November, December, and January; amounting, on the average, in the sheltered places, to five degrees above London" (Sir J. Clark). It is adapted to pulmonary affections, especially those which are attended with a dry cough and are unaccompanied with much expectoration. In dyspepsia, with symptoms of irritation or inflammation, constituting the gastritic dyspepsia of Sir James Clark, it is also beneficial. But in all forms of chronic diseases with copious secretion and exhalation, and a languid and relaxed state of the constitution, it is injurious.

The following are the principal places of resort for invalids along the South-West Coast, taking them in succession from east to west:—

---

[1] *Brighton and its Three Climates*, Lond. 1843.

[2] For an account of the climate of this coast, see Dr. Shapter's *Climate of the South of Devon.*

α. *Sidmouth.*—The climate is damp, and, in November, is subject to sea fogs.

β. *Salterton.*—Preferable to Exmouth. It is well protected from winds, especially the northerly ones.

γ. *Exmouth.*—The higher parts of the town exposed to winds; the lower parts liable to occasional damp. Sir J. Clark declares that it is not adapted for persons with delicate chests.

δ. *Dawlish.*—Next in dryness to Torquay.

ε. *Teignmouth.*—Mild, humid, and relaxing.

ζ. *Torquay.*—This is drier than the other parts of this coast, though its general character is soft and humid. It is almost entirely free from fogs. It is in great repute as a residence for pulmonary invalids.

η. *Salcombe.*—The Montpelier of Huxham. The warmest spot of this coast.

4. SOUTH COAST OF CORNWALL. *Land's End.*—In its general characters this climate resembles that of the south coast of Devon. From the latter, however, it differs, in its greater humidity, and in being more exposed to winds. It is, consequently, more relaxing. The class of cases in which it is calculated to be beneficial or injurious are much the same as those for the south coast of Devon.[1]

The following are the chief places of residence for invalids along this coast:—

α. *Penzance.*—Exposed to the north-east winds during the spring months. Its climate is much more equable than that of London. Thus, though its mean annual temperature is only 1°·77 higher than that of London, yet its winter is 5½° warmer, its summer 2° colder, its spring scarcely 1° warmer, and its autumn about 2½° warmer.

β. *Falmouth.*—The winter temperature is a trifle lower than that of Penzance.

5. WEST OF ENGLAND.—Under this head are grouped the places along the borders of the Bristol Channel and the æstuary of the Severn. The mean temperature of this group is, during the winter, rather lower, but in March and April rather higher, than that of the south coast.

Clifton.—This is the mildest and driest climate in the West of England. It is bracing, and well adapted for scrofulous and relaxed constitutions, with copious secretion and exhalation.

2. *Climates of France.*

The southern climates of France resorted to by invalids may be divided into those of the South-West and those of the South-East of that country.

1. SOUTH-WEST OF FRANCE.—According to Sir James Clark, the climate of this part of France is soft, relaxing, and rather humid; resembling in its general qualities that of the south-west of England. It is favourable to phthisical invalids, for those labouring under bronchial affections, with little expectoration, and for other chronic cases attended with a dry skin.

---

[1] On the climate of this part of England, consult Dr. Forbes's *Observations on the Climate of Penzance and the District of the Land's End*, Penzance, 1820. Also his *Medical Topography of the Land's End*, in the *Provincial Medical Transactions*, vol. ii.

α. *Pau.*—Dr. Playfair[1] thus sums up the qualities of this climate:—"Calmness, moderate cold, bright sunshine of considerable power, a dry state of atmosphere and of the soil, and rains of short duration. Against these must be placed,—changeableness, the fine weather being as short-lived as the bad; rapid variations of the atmosphere within moderate limits. In autumn and spring there are heavy rains." The season extends from September to June.[2]

β. *Bagneres de Bigorre,* in the department of the High Pyrenees, has a mean temperature, during the months of June, July, August, and September, of 66° F. Dr. William Farr[3] declares the climate to be anti-irritating and moist, and to be favourable to the consumptive. It is also beneficial in irritation of the mucous membrane of the trachea and bronchi, with dry cough and viscid expectoration; and also in gastric irritation.[4] Its season is from June to September.

2. South-East of France.—Sir J. Clark says the general character of the climate is dry, hot, and irritating. It is adapted for torpid, relaxed habits, but is decidedly improper for the consumptive and those labouring under irritation and inflammation of the air-tubes.

α. *Montpelier.*—Long but undeservedly celebrated as a residence for phthisical invalids.

β. *Marseilles.*—Exposed to cold winds. Soil dry and arid.

γ. *Hyeres.*—Sir J. Clark declares it to be the least exceptionable residence in Provence for the pulmonary invalid.

3. *Climates of Portugal and Spain.*

Precise information respecting the climates of these countries, to which pulmonary invalids occasionally resort, is much to be desired.

1. Portugal.—Dr. Bullar[5] states that the mean annual temperature of Lisbon is 12° F. higher than that of London; and that the mean temperature of its winter is 16° F. higher than that of London. But notwithstanding its mildness, it is objectionable for persons affected with phthisis, on account of the inequality of its temperature.

2. Spain. — Biscay is subject to sudden and extraordinary changes in temperature, the mercury having been known to rise and fall from 3° to 4° F. within a few minutes.[6] This must, of course, make it an unfit residence for pulmonary invalids.—Madrid is elevated more than 300 fathoms above the level of the sea. Its annual mean temperature is 59° F.[7]—Cadiz, being nearly surrounded by the sea, has a comparatively temperate climate.

4. *Climates of Italy and the Mediterranean.*

The climates included under this head are exceedingly diversified, so that it is difficult to lay down any general character of them.

α. *Nice.*—The climate of this place is somewhat similar to that of the

---

[1] Sir J. Clark's *Sanative Influence of Climate*, p. 192.

[2] Dr. Taylor *On the Curative Influence of the Climate of Pau*, Lond. 1845.

[3] *A Medical Guide to Nice*, Lond. 1841.

[4] Dr. Taylor, *op. cit.* p. 243.

[5] *A Winter in the Azores*, Lond. 1841.

[6] Inglis, *Spain in* 1830, vol. i. p. 39, Lond. 1831.

[7] Humboldt, in De Laborde's *View of Spain*, vol. i. p. clxiii. Lond. 1809.

South-East of France. It is mild, equable, and dry; being adapted for torpid, relaxed individuals, with abundant secretion from the mucous membranes. Dr. William Farr[1] says, the great objection to it is its dryness, and the exciting and irritating nature of its atmosphere. It is beneficial in chronic bronchitis, with copious expectoration; in chronic rheumatism; scrofula; gout; and atonic dyspepsia. It is prejudicial in tubercular disease.

β. *Genoa.*—Climate dry and healthy, with a sharp exciting air. It is adapted for relaxed constitutions, but is unfit for phthisical invalids.

γ. *Florence.*—Not favourable for invalids.

δ. *Pisa.*—According to Sir James Clark, the climate "is genial, but rather oppressive and damp. It is softer than that of Nice, but not so warm; less soft, but less oppressive, than that of Rome." Pisa is frequented by consumptive invalids.

ε. *Rome.*—The climate of this city is one of the best in Italy. Sir James Clark characterises it as being mild, soft but not damp, rather relaxing and oppressive, and remarkable for the stillness of its atmosphere. It is well adapted for phthisis, bronchial affections of a dry irritating kind, and chronic rheumatism.

ζ. *Naples.*—The climate of Naples is warm, variable, and dry. Sir James Clark compares it to that of Nice, but states that it is more changeable, and, if softer in the winter, is more humid. Dr. Cox,[2] however, declares that the mean diurnal variation is far less than is generally supposed. It is an unsuitable residence for most pulmonary invalids, especially those affected with tubercular phthisis. In bronchial cases, with profuse secretion, benefit is sometimes obtained from it. In general debility and deranged health it is also serviceable. Dr. Cox says it is beneficial in dyspepsia, rheumatic neuralgia, and scrofula.

η. *Malta.*—The climate of Malta is mild, dry, bracing, and pretty equable. It is serviceable in chronic bronchitis with profuse secretion, scrofula, dyspepsia, and hypochondriasis.

5. *Atlantic Climates.*

The climates of the Atlantic islands resorted to by invalids may be arranged in two groups; the one eastern, the other western.

1. EASTERN ATLANTIC.—This group includes Madeira, the Canaries, and the Azores.

α. *Madeira.*—The climate of Madeira is mild, humid, equable, and steady. Sir James Clark regards it as the finest in the northern hemisphere. It is superior to all other climates for incipient phthisis. This superiority consists in the mildness of the winter, the coolness of the summer, and the remarkable equability of the temperature during the night and day, as well as throughout the year. Experience, moreover, seems to have fully demonstrated the advantage which patients, with incipient symptoms of consumption, derive from a residence in this island.[3]

---

[1] *A Medical Guide to Nice*, p. 10, Lond. 1841.

[2] *Hints for Invalids about to Visit Naples*, p. 17, Lond. 1841.

[3] For further information respecting the medical qualities of the island of Madeira, the reader may refer with great advantage to Sir James Clark's work, before cited; Dr. Gourlay's *Observations on the Natural History, Climate, and Diseases of Madeira*, 1811; Dr. Renton, in the *Edinburgh Med. and Surg. Journ.* xxvii. 1817; and Dr. Heineken's paper in the *Medical Repository*, xxii. 1824.

β. *The Canaries.*—Teneriffe is the only island of this group possessing accommodation for invalids. Though its mean annual temperature is higher than that of Madeira, its equability is less.

γ. *The Azores or Western Islands.*—Dr. Bullar declares these to be "rather colder than Madeira, and somewhat more equable, and perhaps more humid; but they have not at present those accommodations for strangers which the latter island possesses, nor have they communications by steam with England."[1] St. Michael's, the largest of the Azores, has a mild, humid, equable climate.

2. WESTERN ATLANTIC.—This group includes the Bermudas, the Bahamas, and the West Indies. It is more subject to rapid changes of temperature than the Eastern Atlantic group.

α. *The Bermudas.*—The climate is warm, variable, and dry. The mean annual temperature is considerably higher than that of Madeira; but the climate is variable and windy during the winter, and hot and oppressive in the summer (Sir J. Clark).

β. *The Bahamas.*—The climate is warm, but is subject to rapid changes of temperature. Dry cold winds prevail. Hence the Bahamas are unsuited to consumptive invalids.

γ. *The West Indies.*—The temperature of these islands is too high, and its variations too great, to admit of their being a desirable residence for patients affected with pulmonary consumption; but as a prophylactic for those predisposed to this disease, it is highly spoken of. In scrofula, the climate proves beneficial. Calculous complaints and ossific deposits are rare. The most healthy islands of the group are Jamaica, Barbadoes, St. Vincent's, Antigua, and St. Kitt's.

3. DISEASES FOR WHICH CHANGE OF CLIMATE IS EMPLOYED.

The diseases for which change of climate is most frequently resorted to are as follows:—

1. Pulmonary complaints, especially phthisis, chronic bronchitis resembling phthisis, asthma, hæmoptysis, and diseases of the larynx and trachea.
2. Dyspeptic and hypochondriacal complaints.
3. Chronic rheumatism.
4. Scrofula.
5. Urinary diseases.
6. Liver complaints.
7. In the convalescence from fever, and other acute maladies.

1. PULMONARY COMPLAINTS.—These maladies are benefited by removal from a colder to a warmer climate. Equability, purity, and calmness of the atmosphere, are other desirable qualities in a climate for pulmonary invalids. The nature of the malady and constitution of the patient, however, render all climates possessed of these qualities not equally suited for every case.

α. *Phthisis.*—"For such consumptive patients," observes Sir James Clark, "as are likely to derive benefit from climate, I consider that of *Madeira* altogether the best. *Teneriffe* and the *Azores* approach most nearly in the character of their climate to Madeira." Of the climates of the South of France and Italy the same experienced writer says, when "there exists much sensibility to harsh and keen winds, and, more especially, if immediate vicinity to the sea coast is known to disagree, *Rome* or *Pisa* is the best situation for a winter residence. When, on the contrary, the patient labours under a languid feeble circulation, with a relaxed habit, and a disposition to congestion or to hemorrhage rather than to inflammation,—and, more especially, when the sea air is known by experience to agree,—*Nice* deserves the preference." Late experience has shewn, that *Montpelier*, *Marseilles*, and other places in the south-east of France, once celebrated as affording a good winter climate for consumptive patients, are decidedly improper for phthisical invalids. Of English climates, those of *Undercliff*, *Torquay*, and *Hastings*, are best adapted for this disease. *Torquay* and *Penzance* disagree with persons of a relaxed habit. *Clifton*, during the spring months, often agrees well.

---

[1] *A Winter in the Azores*, Lond. 1841.

β. *Chronic Bronchitis*.—In relaxed constitutions, with copious expectoration, the climates of *Undercliff*, *Clifton*, *Brighton*, and *Nice*, are those which agree best. But, on the other hand, for dry, bronchial, and tracheal irritation, *Torquay*, *Madeira*, *Rome*, and *Pisa*, are to be preferred.

2. DYSPEPSIA AND HYPOCHONDRIASIS.—In selecting a climate for these complaints, we must attend to the character of the malady and the constitution of the invalid. Thus, in the atonic dyspepsia of relaxed and sluggish individuals, with copious secretions, we select a dry and bracing climate; and in such, *Brighton*, *Clifton*, *Nice*, or *Naples*, would probably prove beneficial. But when the dyspepsia assumes an inflammatory form, with dry tongue and a febrile condition of system, the soft and humid climates are to be preferred; such as *Torquay*, *Pau*, *Rome*, and *Pisa*.

3. CHRONIC RHEUMATISM.—In this malady, mild climates generally have been found beneficial. According to Sir James Clark's experience, *Rome* and *Nice* are the best climates on the continent. In relaxed and cachectic individuals, the latter place is to be preferred.

4. SCROFULA.—In this malady the *West Indies* proves highly serviceable. *Nice* and *Rome*, on the continent, have appeared to be favourable. In this country *Clifton* is perhaps the climate best adapted for scrofula.

5. URINARY DISEASES.— Warm climates relieve most affections of the urinary organs, especially calculous complaints, diabetes, and vesical irritation. The benefit probably arises from the excitement of the skin and the abundant cutaneous secretion, and is to be explained on the principle of antagonism already alluded to (see p. 12). In the *West Indies* calculous complaints are very rare.

6. LIVER COMPLAINTS.—Various hepatic derangements are induced by a residence in tropical climates (see p. 13); and in such cases benefit is obtained by a return to the more temperate climates of Europe.

7. In the CONVALESCENCE after fevers and inflammatory diseases, change of climate is often found highly beneficial.

PART IV. MECHANICAL AND SURGICAL REMEDIES.

The consideration of these subjects does not fall within the province of this work.

PART V. PHARMACOLOGICAL REMEDIES.

(*Medicines; Medicamina;* Φάρμακα.)

PHARMACOLOGICAL REMEDIES or MEDICINES are substances, not essentially alimentary, used in the treatment of diseases, and which, when applied to the body, alter or modify its vital actions.

ALIMENTS are vital stimuli (see p. 8, foot-note), which vivify, and can themselves be vivified; since they are assimilated to our organs, and become integrant parts of the living body.

POISONS are distinguished from medicines principally in the *degree* of their effects, and the *uses* to which they are applied; for some of the most powerful poisons become, when administered under proper regulations, very valuable medicines.

PHARMACOLOGY (*pharmacologia,* from φάρμακον, *a medicine;* and λόγος, *a discourse*), or MATERIA MEDICA, is that branch of Acology (see p. 1) devoted to the consideration of medicines. It is subdivided into three departments:—

1. Pharmacognosy.
2. Pharmacy.
3. Pharmacodynamics.

1. PHARMACOGNOSY (*pharmacognosia,* from φάρμακον, *a medicine;* and γιγνώσκω, *I know*) is that department of Pharmacology which treats of the origin, properties, varieties, quality, and purity of *unprepared medicines* or *simples* (*medicamenta cruda*). In other words, it treats of all that relates to the commerce of drugs.

This department of pharmacology is also called by various other names; as *physiographical materia medica* (physiographische Arzneimittellehre)[1], *pharmacography*[2] (pharmacographia, from φάρμακον and γράφω, *I write*), *pharmacomathy*[3] (Pharmacomathie, from φάρμακον and μάθω, *I seek or inquire*), *pharmaceutical merchandise-knowledge* (pharmaceutische Waarenkunde)[4], and the *history of simple drugs* (histoire des drogues simples).[5]

2. PHARMACY (*pharmacia,* from φάρμακον, *a medicine*) is that department of Pharmacology which treats of the collection, preparation, preservation, and dispensation of medicines (*medicamenta præparata et composita*).

This department of pharmacology is sometimes called *chemical materia medica* (chemische

---

[1] Pfaff, *System der Materia Medica,* 1er Band, S. 2, Leipzig, 1808.
[2] A. A. Da Silveira Pinto, *Pharmacographia do Codigo Pharmaceutico Lusitano,* Coimbra, 1836.
[3] Cottereau, *Traité Elémentaire de Pharmacologie,* Paris, 1835.
[4] Goebel and Kunze, *Pharmaceutische Waarenkunde,* Eisenach, 1827–29.
[5] Guibourt, *Histoire Abrégée des Drogues Simples,* 3me éd. Paris, 1836.

Arzneimittellehre,)[1] *pharmacotechny* (pharmacotechnie),[2] *pharmaceutical chemistry* (pharmaco-chemia), and *pharmaconomia.*[3]

The *collection* of unprepared medicines or simples involves their selection, emendation or preliminary preparation, and desiccation. *Simples* are either *foreign* or *indigenous*. The former are imported by the merchant, and sold on his behalf, by the drug-broker, to the wholesale druggist.

Indigenous vegetable substances are usually collected by the simpler (ῥιζοτόμος[4]) or herbalist. Most of the plants grown in this country, and for which there is a large consumption, are cultivated at Mitcham and other places.

The *preparation* of medicines has for its object the division, separation, mixture, or chemical combination of substances.

The various operations by which these objects are effected are described in works expressly devoted to pharmacy; and to these I must refer the reader for further information on this subject. A summary of them would be practically useless, while it would occupy space which can be advantageously employed with the consideration of topics which are strictly within the scope of the present work.

3. PHARMACODYNAMICS (*pharmacodynamica,* from φάρμακον, *a medicine;* and δύναμις, *power*) is that department of Pharmacology which treats of the effects and uses of medicines.

This department of pharmacology is called *dynamical materia medica* (dynamische Arzneimittellehre) by Pfaff.

Pharmacology is either *general* or *special.*

DIV. I.—General Pharmacology.

General Pharmacology (*pharmacologia generalis*) treats of medicines generally.

The general pharmacological subjects which require examination may be conveniently considered in the following order:—

1. Modes of ascertaining the effects of medicines.
2. Active forces of medicines.
3. Changes which medicines undergo in the organism.
4. Physiological effects of medicines.
5. Therapeutical effects of medicines.
6. Parts to which medicines are applied.
7. Classification of medicines.

All these subjects belong to that department of pharmacology which may be termed *general pharmacodynamics.*

1. MODES OF ASCERTAINING THE EFFECTS OF MEDICINES.

Formerly the virtues of medicines were inferred from resemblances (fancied or real) in form, colour, &c. between these substances and parts of the organism. These marks or indications were called *signatures*, and were supposed to arise from astral influences.[1]

---

[1] Pfaff, *op. cit.*

[2] Cattereau, *op. cit.*

[3] A. A. Da Silveira Pinto, *Codigo Pharmaceutico Lusitano, ou Tratado de Pharmaconomia,* Coimbra, 1835.

[4] For a notice of the ancient rhizotomist, see the *Historical Table,* art. *Greek Medicine.*

There are four principal methods which, in modern times, have been resorted to for the purpose of determining the effects of medicines. These are founded, respectively, on—

1. The sensible qualities of medicines.
2. The natural-historical properties.
3. The chemical properties.
4. The dynamical properties.

1. THE SENSIBLE QUALITIES OF MEDICINES.—*Colour*, *taste*, and *odour* have been used to indicate, in a very general way, the medicinal properties of plants. But to all the general propositions which have hitherto been advanced concerning them, so many exceptions exist, that none possess much, if any, practical value.

It appears to me to be a waste of time and space to dwell on this subject; I beg, therefore, to refer the reader, for further information, to the writings of Linnæus,[2] Cullen,[3] and Edwards and Vavasseur.[4] In another part of this work, I shall have occasion to notice Mr. Greeves's classification of the articles of the Materia Medica according to their sensible qualities. In connection with this subject I may observe that some interesting information on the colour, odour, and taste of plants, is contained in Landgrebe's work on Light.[5]

2. THE NATURAL-HISTORICAL PROPERTIES.—*Exterior form* and *structure* are made use of, in natural history, to determine the affinities of natural bodies: hence they are denominated *natural-historical properties*.

α. *Minerals.*—No conclusions, respecting the medicinal properties of minerals, can be deduced from crystalline form and structure.

Mr. Blake asserts,[6] that the most striking points of resemblance exist generally between isomorphous compounds in their action on the animal tissues when *introduced into the blood*. Be this as it may, their action, when *taken into the stomach*, is often very dissimilar. Thus, the triphosphate of soda is isomorphous with the triarseniate of the same base; but no one will pretend to assert that their action on the system is alike. Arsenious acid is isomorphous with sesquioxide of antimony; yet their effects on the system are very dissimilar. Mr. Blake admits that the salts of lead and of silver are exceptions to his statement; their action on the pulmonary tissue being analogous, though they are not isomorphous.

β. *Vegetables.*—It has long been supposed, that those plants which resemble each other in their external appearances are endowed with analogous medicinal properties. Cæsalpinus was, according to Dierbach,[7] the founder of this doctrine; though De Candolle[8] regards Camerarius as the first who clearly announced it. Linnæus[9] says, "Plantæ quæ *genere* conveniunt, etiam virtute conveniunt; quæ *ordine* naturali continentur, etiam virtute propius accedunt; quæque *classe* naturali congruunt, etiam viribus quodammodo congruunt." I may also refer to Isenflamm, Wilcke, Gmelin, Jussieu, and

---

[1] See Sprengel, *Histoire de la Médecine*, t. iii. p. 321, Paris, 1815. Also, Schroder's *Compleat Chymical Dispensatory*, by Rowland, Lond. 1669.

[2] *Philosophia Botanica*, p. 283, ed. 4ta, 1787.

[3] *A Treatise of the Materia Medica*, vol. i. p. 138, Edinb. 1789.

[4] *Manuel de Matière Médicale*, Paris, 1831.

[5] *Ueber das Licht*, Marburg, 1834.

[6] *Edinburgh Med. and Surg. Journ.* for July, 1841.

[7] *Abhandlung über die Arzneikräfte des Pflanzen, vergleichen mit ihrer Structur und ihren chemischen Bestandtheilen*, Lemgo, 1831.

[8] *Essai sur les Propriétés Médicales des Plantes*, p. 4, 2de éd. Paris, 1816.

[9] *Op. supra cit.* p. 278.

Barton, as other supporters of this opinion. But the most important writer in favour of it is De Candolle, who, in 1804, published the first edition of his work on this subject. In the year 1831, we had another interesting treatise on the same subject, by Dierbach. There are other writers, however, who deny altogether the possibility of judging of the virtues of plants by their exterior forms and botanical characters. Of these, it will be sufficient to mention Gleditsch.[1]

Vegetable substances owe their peculiar qualities to the structure, and consequent action, of the organs producing them; and, therefore, differences in the structure of an organ are attended with corresponding differences in the qualities of its products. It consequently follows, that the medicinal qualities of plants of the same natural order should be similar or analogous; and that they are so to a certain extent is fully ascertained by numerous facts: thus, if one vegetable species serve as nutriment for either animal or plant, we frequently observe that other species of the same genus, or even of a different genus, but of the same order, are also adapted for a like use; while, on the other hand, if any particular species be injurious, neighbouring species are likewise more or less so. Experience has fully proved, that in a very large number of instances there exists an analogy between the exterior forms and the medicinal properties of plants, so that we can sometimes predict the active principle and mode of operation of a vegetable, merely by knowing to what part of a natural arrangement it belongs. *Gramineæ, Melanthaceæ, Coniferæ, Labiatæ, Malvaceæ, Cruciferæ,* and *Ranunculaceæ,* are familiar illustrations of the accuracy of these observations.

There exist, however, many anomalies or exceptions to the statements now made. These are of two kinds:—

1st. Plants of the same natural order are frequently endowed with dissimilar medicinal properties.

The root and leaves of *Daucus Carota* are wholesome and nutritive; but the analogous parts of *Conium maculatum* are highly poisonous. Both of these plants, however, belong to the same natural order—UMBELLIFERÆ. In some cases we find plants even of the same genus differing considerably in their medicinal properties; as *Cucumis Melo* and *Cucumis Colocynthis,* of the order CUCURBITACEÆ. If we are to believe the statements of creditable writers, even GRAMINEÆ, which De Candolle declares to be "la famille la plus naturelle," contains more than one exception to the general statement in question. For the most part, the plants of this family are farinaceous and nutritive. "None," says Dr. Lindley,[2] "are unwholesome in their natural state, with the single exception of *Lolium temulentum,* a common weed in many parts of England, the effects of which are undoubtedly deleterious, although perhaps much exaggerated." I may remark, however, that several other grasses have been asserted to be unwholesome. Loudon[3] tells us that the seeds of *Bromus mollis* bring on giddiness in the human species and quadrupeds, and are fatal to poultry. The root of *Bromus purgans* is said to be used in Canada as an emetic, in doses of forty grains. *Bromus catharticus,* a Chilian plant, has a thick root, which is stated to act as a purgative.[4] And Humboldt[5] informs us that *Festuca quadridentata* (fig. 6) is very poisonous, and even fatal to animals.[6]

---

[1] *De Methodo Botanico dubio et fallaci virtutum in plantis indice,* ed. 2nda, Lipsiæ, 1742.

[2] *Natural System,* 2d ed. 1836.

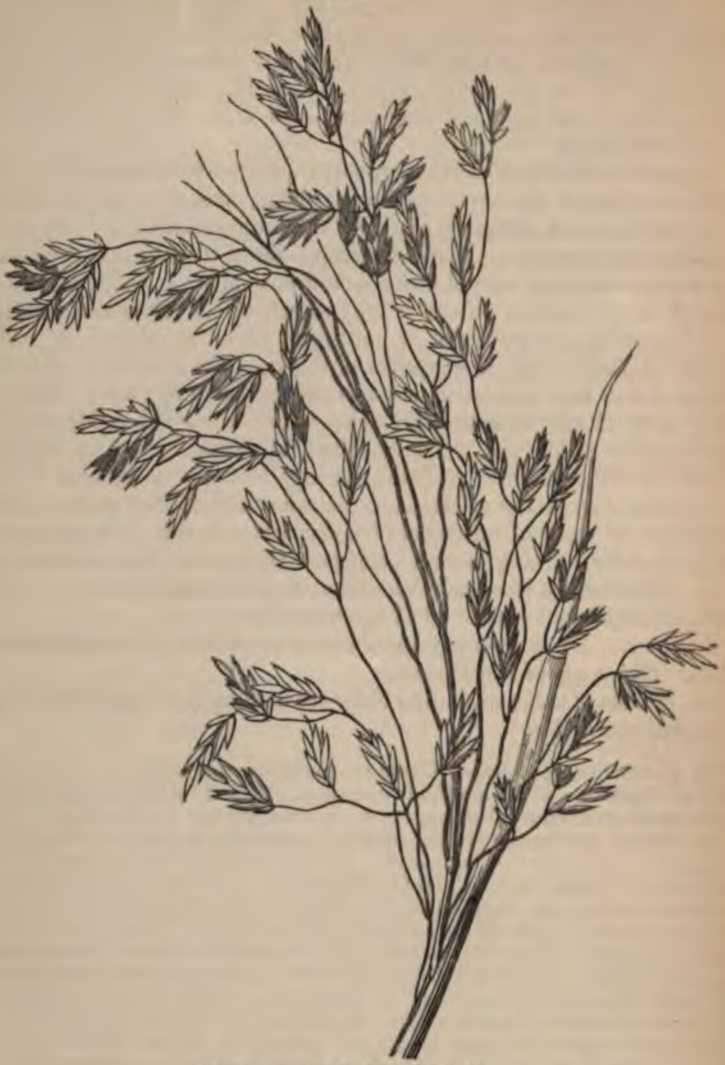
[3] *Encyclopædia of Plants,* p. 64.

[4] *Dictionn. de Matière Médic. par F. V. Merat et A. J. De Lens,* tom. i. p. 672.

[5] *Voyage,* t. i.

[6] Is this the grass described by some under the name of *Carapoucha,* and which by others has been called *Carapullo?* Frezier (*Voyage to the South Sea and along the Coasts of Chili and Peru,* in the years 1712, 1713, and 1714,) says, in speaking of Lima, "There is an herb called *Carapullo,*

FIG. 6.



Festuca quadridentata (Kunth).

---

which grows like a tuft of grass, and yields an ear, the decoction of which makes such as drink it delirious for some days. The Indians make use of it to discover the natural disposition of their children. All the time when it has its operation, they place by them the tools of all such trades as they may follow,—as by a maiden, a spindle, wool, scissors, cloth, kitchen furniture, &c.; and by a youth, accoutrements for a horse, awls, hammers, &c.: and that tool they take most fancy to in their delirium, is a certain indication of the trade they are fittest for,—as I was assured by a French surgeon, who was an eye-witness of this verity." On this statement, Dr. Lindley (*Flora Medica*, p. 613, Lond. 1838,) remarks, that it is uncertain whether the plant referred to be really of the order Gramineæ. "I cannot trace the name," he observes, "and the only Lima plant that I find bearing a name at all like it, is Physalis pubescens, which, according to the *Flora Peruviana*, is there called *Capuli*."

In the family SOLANEÆ we meet with other exceptions, as in the fruit of *Capsicum annuum* and *Atropa Belladonna.* I might select many other instances to the same effect, but shall content myself with the examples already adduced, as sufficiently warranting the assertion that, in the present state of science, botanical affinities cannot be *confidently* relied on by the medical practitioner for determining the effects of remedial agents.

2dly. Plants of dissimilar structure are sometimes endowed with similar or very analogous medicinal properties.

An oleo-resinous juice, called turpentine, is obtained from *Pistachia Terebinthus,* a plant of the order TEREBINTHACEÆ, and a substance possessing almost identical properties, and bearing the same name, is procured from the genera *Pinus, Larix,* and *Abies,* of the order CONIFERÆ. Balsam of Copaiba, which agrees with the turpentines in all its leading properties, and whose constituents are actually isomeric with those of the turpentines, is procured from LEGUMINOSÆ. Yet the structure of Coniferæ is totally dissimilar to that of either Terebinthaceæ or Leguminosæ. Again, the effects of *Lobelia inflata,* a plant belonging to the order LOBELIACEÆ, are so analogous to those of *Nicotiana Tabacum,* which belongs to SOLANACEÆ, that the first-mentioned plant has received the name of Indian *Tobacco.* The term *Hellebore* (ἐλλέβορος) has been applied to two very different plants, viz. *Helleborus niger* and *Veratrum album,* in consequence, I presume, of an observed similarity of operation (both being drastic purgatives and narcotico-acrids); yet the first-mentioned plant is an exogen or dicotyledon, and belongs to the order RANUNCULACEÆ,—while the second is an endogen or monocotyledon, of the order MELANTHACEÆ.

γ. *Animals.*—No attempts have been made to trace a relation between the toxicological, medicinal or edible properties, and the anatomical structure of animals. This has probably arisen from the comparatively small number of these beings which possess medicinal or poisonous propertles; for we are enabled to employ, as food, animals of every class, from the highest to the lowest. Among quadrupeds and birds no species is poisonous,[1] unless, indeed, the Arctic bear be an exception, whose liver is stated by Captain Scoresby[2] to be deleterious. Among fishes, mollusks, and insects, however, several species are hurtful; and it is frequently found that where one is deleterious, kindred species are likewise more or less so. Thus all the coleopterous insects belonging to the tribe *Cantharidiæ* of Latreille possess blistering properties.

3. THE CHEMICAL PROPERTIES of medicines have been sometimes resorted to for the purpose of determining the influence which these bodies have over the organism. For we sometimes find that substances possessed of similar chemical qualities operate in an analogous manner on the system. Thus sulphuric, nitric, and hydrochloric acids act very much alike; as do also potash and soda. But these analogies are not common: and we frequently meet with substances whose chemical properties are similar, but whose medicinal qualities are most incongruous, as in the case of quina and morphia; while, on the other hand, bodies whose chemical properties are exceedingly unlike, sometimes act in a very analogous manner; for example, manna and bitartrate of potash.

The properties of bodies are so completely altered by chemical combination, that it is, in most cases, difficult to form a correct opinion as to the action of a compound medicine, merely by knowing the nature and proportion of its constituent parts. The compounds of some of the metals, however, offer exceptions to this statement.

---

[1] Fleming's *Philosophy of Zoology,* vol. ii. p. 110, Edinb. 1822.

[2] *Account of the Arctic Regions,* vol. i. p. 520, Lond. 1820.

Mr. Blake[1] contends that a very close relation exists between the chemical properties and physiological effects.

4. THE DYNAMICAL PROPERTIES. *Observation of the effects caused by the application of medicines to the animal body.*—Some have examined the action of medicines on *dead* animal tissues, and drawn inferences therefrom as to the operation on the living organism. This mode of proceeding was adopted by Dr. Adair Crawford.[2] But it is admissible only for those remedies whose action is either physical or chemical.

The examination of the effects of medicines on *living* animals is a much more valuable and important mode of investigation; for it may be asserted, as a general rule, that a substance which is poisonous to one speces is more or less so to all classes of animals; and in a considerable number of instances, its action is of the same nature or quality, though usually very different in degree, and modified by the variations in the development of the several organs and functions. It has, indeed, been stated that many substances which are poisonous to man are innocuous to animals, and *vice versâ.* That this statement is wholly untrue, I will not venture to affirm, but I think that it is an exaggerated one; and I believe, with Dr. Christison,[3] that "if the subject be studied more deeply, the greater number of the alleged diversities will prove rather apparent than real."

The principal differences observed in the operation of medicines on our domestic animals, and which depend on peculiarities of organisation and modes of sensibility, may be conveniently arranged under three heads, as follows:—

α. Those relating to the nervous system.
β. Those connected with the structure of the digestive organs.
γ. Those relating to the skin.

α. To peculiarities in the organisation of the *nervous system* of different animals are to be referred the diversities observed in the operation of certain medicines on different animals. Thus opium, which in man usually produces sleep, sopor, or coma, generally produces convulsions in other animals, and, according to Charvet,[4] "never coma, loss of consciousness, nor profound sleep." I have observed that the root of monkshood does not act precisely alike on rabbits and dogs. In the latter, one of the most remarkable symptoms of its operation is diminution of feeling; in the former, the function of feeling is much less obviously affected, but we observe more evident paralysis of the hind extremities, and muscular weakness.

β. From differences in the structure of the *digestive organs* arise some peculiarities in the operation of medicines. In carnivorous animals, vomiting can be readily excited; whereas in herbivorous ones, as the horse and the rabbit, it is either not effected at all, or only with extreme difficulty. The rumen or paunch of ruminants possesses but little sensibility and few blood-vessels, and is very slightly affected by medicinal agents. Hence, in the administration of medicines to these animals, it is necessary to let them trickle slowly down so that they may flow along the œsophagean canal, and through the manyplies or third stomach, into the abomasum, or fourth or true stomach; and the late Mr. Youatt[5] ascribed the occasional inertness of ergot of rye on the ruminant to its being hastily poured from a large vessel, by which it falls into the paunch, and there remains inert. Lastly, it is remarkable that colocynth, jalap, gamboge, and bryony, which operate as violent purgatives on man and carnivorous animals, have comparatively little effect on the horse and other herbivorous animals.[1]

---

[1] *Proceedings of the Royal Society*, Jan. 28th, 1841.

[2] *An Experimental Inquiry into the Effects of Tonics and other Medicinal Substances*, London, 1816.

[3] *Treatise on Poisons*, 4th ed. p. 73.

[4] *De l'Action comparée de l'Opium*, p. 164, Paris, 1826.

[5] See the article "*Ergot of Rye.*"

γ. The *skin* also presents some peculiarities in the operation of medicines. Thus dogs are but little under the influence of sudorifics; while the skin of horses is exceedingly susceptible of the action of oil of turpentine.

In ascertaining the action of remedial agents on the *human* body, it is necessary that we should examine their influence both in healthy and diseased conditions. For by the first we learn the positive or actual power; while by the second we see how that power is modified by the presence of disease. Moreover, in the latter condition we sometimes discover remedial influences which our knowledge of the effects of medicines on the healthy body could not have led us to anticipate. The beneficial operation of arsenious acid in agues, or in lepra, could never have been inferred from any experiments made with this substance in health merely; nor could we have formed a correct estimate of the effects and proper dose of opium by employing it in tetanus, nor by using mercurials in fever. The homœopathists assert, and with truth, that the study of the effects of medicines in the healthy state is the only way of ascertaining the *pure* or *pathogenetic* effect of medicines—since when we administer our remedies to invalids "the symptoms of the natural disease, then existing, mingling with those which the medicinal agents are capable of producing, the latter can rarely be distinguished with any clearness or precision."[2]

2. ACTIVE FORCES OF MEDICINES.

The production of effects, by the application of medicines to the living body, depends on the existence of two classes of powers or forces: the one residing in the medicine, and called the *active forces of medicines;* the other in the organism.

Bodies act on each other in one or more of three ways; viz. *physically,* by their weight, cohesion, external form, motion, &c.; *chemically,* by their mutual affinities; and *dynamically,* by agencies which are neither physical nor chemical merely. Hence we may examine the agencies of medicines under the three heads of physical, chemical, and dynamical.

1. PHYSICAL FORCES.—Alterations of cohesion, form, relative position, &c. are produced by physical forces. They are attended or followed by organic changes; and, therefore, a medicine whose action is simply physical produces two classes of effects—the one physical, the other vital; and the whole of its operation may be denominated *physico-vital.*

The *iatromechanical* or *iatromathematical* physicians explained the functions of the body, the production of diseases, and the operation of medicines, on mechanical principles. Thus stimulants were supposed to act by their pointed and needle-shaped particles, and emollients by their globular particles.[3] Locke[4] believed that the mechanical affections of medicines would explain the operation of these agents.

Several of the processes to which medicines are subjected before they are administered, have for their principal object the prevention or diminution of the mechanical influence of these agents. The hairs of the pods of ***Mucuna pruriens***, quicksilver, and the agents termed demulcents, act by their mechanical properties. Many substances act endosmotically (see p. 94).

---

[1] Moiroud, *Pharmacologie Vétérinaire*, pp. 51, 269, and 274.

[2] Hahnemann's *Organon*, translated by C. H. Devrient, p. 190.

[3] Sprengel, *Hist. de Médec.* by Jourdan, t. v. p. 131, et seq.

[4] *Essay concerning Human Understanding*, book iv. chap. iii.

2. CHEMICAL FORCES.—If substances, having powerful affinities for organic matter, be applied to the living tissues, they combine with the organic constituents, and act as *caustics* or *escharotics*. By the destruction of life in one part, alterations of vital actions in neighbouring parts ensue; so that the action of caustics is attended by both chemical and vital effects; and the whole operation may be denominated a *chemico-vital process*.

By dilution, the energy of the affinity of caustics for organic matter may be so diminished, that they are incapable of destroying the life of the part, but merely disturb and alter the organic activity. This effect is termed *irritation*, and the agent inducing it is called an *irritant*. In this case the active force is still supposed to be affinity; that is, the particles of the caustic are presumed to have a tendency to unite with those of the organised tissues; but the union being resisted by the vital powers, a new action is set up, which constitutes the changes or effects before referred to. The long-continued application, however, of weak chemical agents will gradually effect slight changes in the composition of the tissues without producing the death of the altered parts; and these organic alterations are attended by the production of morbid actions.

Chemical changes are sometimes produced in the secretions of distant parts by the internal use of certain agents. Thus the qualities of the urine are modified by the administration of acids or alkalies; and as the modifications produced are precisely those which we might expect from the known chemical properties of these bodies, it is rational to infer that they are effected by chemical affinity.

Are the constitutional effects of acids, alkalies, metallic salts, &c. referable to chemical influences? We cannot deny the chemical power of these agents; but we are hardly authorised to ascribe the whole of their effects to it. The truth is, that the facts on which we are required to form our opinion are too few to enable us to draw any accurate or precise conclusions. We know that, by the internal use of madder, the bones and some other parts become coloured; and that the long-continued employment of the nitrate of silver occasionally gives rise to a deposit of silver under the skin; but with two or three exceptions of this kind, no chemical changes in the living tissues have been demonstrated.

Müller[1] ascribes the operation of most external agents to their chemical influence. "A great number of substances are important as medicaments, from producing a chemical change in the organic matter, of which the result is, not an immediate renovation of material and increase of vital force, but the removal of that state of combination of the elements which prevented healthy action, or excited diseased action; or the chemical change produced is such as to render the organ no longer sensible to a morbid stimulus; or it is such that certain apprehended destructive changes in its composition are no longer possible, as in the antiphlogistic plan of treatment; or, lastly, these substances produce a change in the nutritive fluids. Such substances are *alteratives*. By these remedies an organ morbidly changed in composition cannot be rendered sound by, as it were, a chemical process, but such a slight chemical change can be produced as shall render it possible for nature to restore the healthy constitution of the part by the process of nutrition."

The attempted explanation of the effects of medicines on chemical principles does not give a satisfactory explanation of the phenomena. How is it that the same remedy acts so unequally on different animals, on different individuals of the same species, and on the same individual at different periods? Why is the effect of opium greater proportionally on the child than on the adult? Are we to assume that the constituents of the brain of the young animal have more affinity for morphia than those of the brain of old animals?

---

[1] *Elements of Physiology*, by Baly, vol. i. p. 58, et seq.

The action of a medicine on one organ rather than on another is accounted for on the chemical hypothesis, by assuming the existence of unequal affinities of the medicinal agent for different tissues. Thus the action of alcohol on the brain is ascribed to the affinity of this liquid for the cerebral substance.[1]

3. Dynamical Forces.—Some substances exercise a most potent influence over the organism, without producing any obviously physical or chemical changes in the organic tissues. Such substances are said to act *dynamically.*

In the inorganic kingdom we have evidence of an influence which cannot be denominated either mechanical or chemical. The communication of magnetical and electrical properties to iron by mere contact with another body, without the production of any change of form or of composition, either of the iron itself or of the imparting body, is an example of this. Now, to influences of this kind the term *dynamical* has been applied; and several pharmacologists[2] have employed it to indicate those influences of medicines over the organism which are ascribable to neither mechanical nor chemical causes. As the term is a convenient one, I have adopted it.

Bischoff[3] regards the action of medicines on the organism as electrical, or, in some cases (as that of caustics), as electro-chemical.

In some few instances the effects of medicines are analogous to those of electricity. Thus the instantaneous death caused by hydrocyanic acid is somewhat like the effect of a stroke of lightning; and the convulsive paroxysm induced by touching an animal under the influence of strychnia or nux vomica is analogous to the effect of an electric shock.

3. Changes effected in Medicines by the Action of the Organism.

The changes which medicines suffer by the action of the organism are either physical or chemical, or both. They are effected by the mutual affinities which exist between the medicines or their parts and the substances with which they are brought in contact; and are modified by the temperature of the body, and by the relative proportions of the reacting bodies.

The rapidity with which volatile substances pervade the system and reappear in distant organs, must be greatly aided by the heat of the animal body. Sulphuric ether, for example, boils at 98° F.; that is, at the temperature of the blood; and the rapidity of its action is undoubtedly in part owing to its great volatility. Hydrocyanic acid, another swiftly-acting substance, boils at about 80° F.

The influence of quantity is illustrated in the case of alcohol. The non-coagulation of the blood by the absorption of rectified spirit from the stomach is to be ascribed to the influence of the mass of the blood; for a minute quantity of alcohol may be mixed with a large quantity of albumen without causing the coagulation of the latter.

The chemical changes which a medicine suffers in the part of the body with which it first comes in contact, are produced by the secretions of the part; or by the constituents of the living tissues; or, when it is injected into the blood-vessels, by the blood itself; or, when it is introduced into the alimentary canal, by the substances contained within this tube.

---

[1] See Dr. Percy's *Experimental Inquiry concerning the Presence of Alcohol in the Ventricles of the Brain after Poisoning with that Liquid*, Lond. 1839.

[2] Burdach, *System der Arzneymittellehre*, Leipzig, 1807; C. H. E. Bischoff, *Die Lehre von den chemischen Heilmitteln*, Bonn, 1825; Vogt, *Lehrbuch der Pharmakodynamik*, 2te Aufl. Giessen, 1828.

[3] *Op. supra cit.* Bd. i. pp. 158, 162, and 163.

The secretions protect, to a certain extent, the living surface from the action of the medicinal agent. The protection is complete when the quantity of the medicine is small; it is incomplete when the quantity is large, and the energy of the affinities intense.

The precise nature of the changes which medicines undergo when they first come into contact with the body, has been carefully investigated in a very few instances only. For the greater number of medicines, accurate observations are entirely wanting; and we form our opinion of the nature of the changes principally by analogy, aided, in particular cases, by some isolated fact. Those which are best known are as follows:—

α. Some substances remain unchanged, and being insoluble are inert or act mechanically; as *woody fibre*, which forms a leading constituent of all medicinal roots, barks, woods, fruits, and seeds. When these substances are swallowed, the woody fibre is evacuated with the fæces.

β. Some substances undergo no obvious chemical change, but, being liquid or soluble, mechanically mix with the fluids of the part to which they are applied, and become absorbed: as various *aqueous liquids*, holding in solution *colouring*, *odorous*, and other matters; *oil*, *alcohol*, *ether*, &c.

γ. Some substances undergo more or less chemical change by the action of acids, bases, salts, albumen, casein, ptyalin, pepsin, or other substances with which they come in contact; and the newly-formed body is, if soluble, absorbed, but not otherwise.[1]

The *alkaline and earthy carbonates* are decomposed by the acids of the alimentary canal, with the evolution of carbonic acid.

Most of the *metallic oxides*, and the *metallic*, *alkaline*, and *earthy salts*, form new compounds with albumen, casein, &c.

Chalybeate preparations, when swallowed, are partly converted into sulphuret of iron, which darkens the fæces.

The *acids*, both inorganic and organic, combine with bases; and the salts which are thereby formed unite with organic matters.

Calomel yields a soluble mercurial compound.

The medicinal activity of a substance is sometimes greatly modified by the chemical changes thus effected in it.

Chemical antidotes are effective by rendering poisons insoluble.

Insoluble substances, by becoming soluble, acquire medicinal activity, as in the case of calomel.

Insoluble compounds formed in the blood, by the action of medicinal agents injected into the blood-vessels, accumulate in the capillaries, and act there as mechanical irritants. Newly-formed soluble compounds, however, circulate with the blood.

Subsequent to their absorption, and while still within the system, medicines sometimes undergo various chemical changes. The reduction of the preparations of mercury and silver, and the deposition of these metals in the living tissues, are illustrative proofs.

---

[1] Since the above was in type some experiments, made by Oesterlen, have been published, which apparently prove the possibility of the absorption of insoluble substances (*Monthly Journal of Medical Science* for May, 1847).

Medicinal agents are ultimately expelled from the system by the excreting organs; and we can frequently detect them in the excretions; sometimes unchanged; at other times, more or less altered, or in combination with some other substance.

α. *Many salts*, as chlorate and nitrate of potash; *colouring matters*, as that of rhubarb; and various other substances, are found in the urine unchanged, or nearly so.

β. Some *odorous substances* are found in a somewhat altered state: thus oil of turpentine is found to have acquired a violet odour.

γ. Many substances are discharged from the system in combination with some other body: thus the *vegetable acids* are found in the urine in combination with bases.

δ. Other bodies are found in a more or less decomposed or altered state. The *alkaline salts which contain a vegetable acid* are converted into alkaline carbonates, which are found in the urine; and *benzoic acid* is converted into hippuric acid, which also occurs in the urine.

In some cases, the compounds found in the excretions may have been formed after their constituents were thrown out of the system. Thus the union of oxalic acid with lime, and the formation of octahedral crystals of oxalate of lime, must have taken place after the oxalic acid was secreted by the kidney.

4. PHYSIOLOGICAL EFFECTS OF MEDICINES.

The effects which medicines are capable of producing in healthy individuals are denominated *primary*, *immediate*, or *physiological*.

Formerly no distinction was made between the effects which medicines produce in health, and those which they give rise to in disease; and the terms *virtues*, *properties*, *faculties*, and *powers*, were applied to both classes of effects. But Bichat, and subsequently Barbier and Schwilgué, pointed out the propriety of considering them separately.

By the term *effects* are meant the symptoms or perceptible alterations produced by medicines in the aspect or functions of organs. They are of two kinds: those which arise from the direct action of medicines, and those which result from the reaction of the organism.

Thus the concentrated mineral acids and alkalies decompose the tissues of both living and dead bodies by uniting with some of their constituents, and thereby produce certain chemical alterations which we denominate the effects of the action of these agents. In the living body, inflammation is set up in the tissue surrounding the cauterised part; and the vital alterations which are in consequence induced are called the effects of the reaction of the organism.

The action of medicines depends on their active forces already noticed: the reaction of the organism on the vital force.

In many instances, the nature of the action of medicines is unknown, as in the case of aconitina, strychnia, and the acrid volatile oils and resins. For these agents are without any obvious influence on the dead body; and the effects which they give rise to when they are applied to the living body are referable to the reaction of the organism.

1. *Nature or Quality of the Physiological Effects.*

The physiological effects of medicines may be—

1. Physico-vital,
2. Chemico-vital, or
3. Purely vital.

A medicine whose action is either physical or chemical, gives rise to vital changes by exciting the reaction of the organism, and thus its total effects are neither purely physical nor purely chemical, but physico-vital or chemico-vital. The effects of some medicines are purely vital: at least, neither physical nor chemical changes are perceptible.

It will be convenient to consider separately the physical, chemical, and vital effects.

1. PHYSICAL EFFECTS.—The physical influences of medicines deserve to be more carefully investigated than they have hitherto been, as they are probably much more important than is usually supposed.

a. Some medicines act by their external form and weight.—Thus quicksilver, when swallowed to the extent of several ounces, operates by its weight on the bowels; and woody fibre, the hairs of *Mucuna pruriens*, silica, glass, and other substances which undergo little or no change in the alimentary canal, act as foreign bodies by their external form and weight.

β. Many medicines produce physical effects on the body by their influence over the phenomena of endosmose and exosmose.

When the serum of the blood is separated from another liquid by an organic membrane, two currents are in general established through the membrane; one from the serum to the solution, the other from the solution to the serum. When the intensity of the first exceeds that of the second, it is called *endosmose of the serum;* but when the intensity of the second exceeds that of the first, it is termed *exosmose of the solution.*[1] In some few cases, presently to be noticed, this double current or mutual permeation does not take place.

1. *Substances which undergo endosmose and exosmose with the serum of the blood.*—The kind of endosmotic influence which these bodies exercise varies, in many cases, with the degree of concentration of the solutions. Very concentrated solutions in general cause endosmose of the serum; whereas dilute solutions have a reverse effect, and give rise to endosmose of the solution; and for solutions of a certain intermediate strength, the two currents are equal.

a. Substances which cause endosmose of the serum.—This division includes concentrated solutions of various salts (phosphate of soda, nitrate of potash, chloride of sodium, iodide of potassium, tartrate of potash, sulphates of soda and potash, phosphate of potash, and alum), native seidlitz water, Pullna water, sufficiently concentrated solutions of certain vegetable purgatives (manna, and the extracts of senna, rhubarb, the herb mercury, tamarinds, cassia, colocynth and aloes, resins of scammony and jalap, and castor oil), of various narcotic substances (one part of the alcoholic extract of the following substances to five parts of water: black hellebore, hemlock, henbane, aconite, and belladonna), solution of cane sugar (this causes a very powerful current), dilute spirit, and a solution of cantharidin in olive oil (prepared by digesting one part of powdered cantharides in two and a half parts of oil at 176° F.)

---

[1] Poiseuille, *Comptes rendus*, t. xix. p. 944, 1844.

β. *Substances which cause endosmose of the solution.*—This division includes water (which produces the strongest current), dilute solutions of salts (phosphate of soda, nitrate of potash, chloride of sodium, and iodide of potassium), solutions of certain acids) acetic, tartaric, citric, and sulphuric acids), of ammonia, of nitrate of strychnia, and of sulphate of quina, hydrocyanic acid, laurel water, and certain non-purgative mineral waters (viz. those of Passy, Spa, Vichy, Plombières, Cauteretz, Mont d'Or, &c.)

2. *Substances which do not undergo endosmose and exosmose with the serum of the blood.*—These may be arranged in two divisions:—

α. *Substances which penetrate the membrane, and render it unfit for endosmose.*—To this division belong the solution of sulphuretted hydrogen and decoction of tobacco. Under the influence of either of these liquids, the membrane becomes permeable, and yields to that liquid which exercises the greatest amount of pressure.

β. *Substances whose presence puts a stop to the phenomena of endosmose, and renders the membrane impermeable to either liquid.*—To this division belongs the solution of hydrochlorate of morphia.

The endosmotic influence of medicines may be exercised when they are applied to the body, and before they become absorbed, as well as after their absorption into the blood. In the first case, it is exerted through the coats of the vessels on the blood; in the second case, it is exercised either through the membrane of the blood corpuscles on the fluid contained within them, or through the coats of the capillaries on the parenchyma of organs.

As absorption and nutrition are phenomena of endosmose, it is obvious that the endosmotic influence of medicines, by modifying these functions, must greatly contribute to the production of the effects of medicinal agents; though, in the present state of our knowledge, it is not possible to state precisely the exact share which this influence has in the production of the effects. The following, however, are a few illustrations of the attempted application of the endosmotic influence of medicines to the explanation of their physiological effects.

1. Substances which, when introduced into the alimentary canal, produce endosmose of the serum, usually act as purgatives;[1] for example, concentrated saline solutions, solutions of cathartic extracts, &c. Poiseuille found, after the use of saline purgatives, a considerable quantity of albumen in the alvine excretion. All substances, however, which produce endosmose of the serum are not purgatives,—as solution of cane sugar. Poiseuille ascribes this to the conversion of the sugar into lactic acid, which, like several other vegetable acids, causes endosmose of the solution.

2. While saline solutions whose specific gravity is greater than that of the serum of the blood (1·027 to 1·029) produce endosmose of the serum, and consequent purgation, weak saline solutions whose specific gravity is less than that of the serum of the blood produce endosmose of the solution;[2] and when introduced into the alimentary canal, they become speedily absorbed, and, by their action on the kidneys, excite diuresis. Hence the necessity of administering solutions which are intended to reach the kidneys in a dilute form, and of a lower density than that of the serum of the blood.

3. A solution of hydrochlorate of morphia added to a saline solution, first checks, then entirely stops, the endosmose of the serum, and afterwards reverses the current, and produces endosmose of the solution. The efficacy of morphia and opium in checking the purgative effects of other substances, and in causing constipation, has been ascribed by Poiseuille to this endosmotic influence.

4. Dr. G. Owen Rees[3] has shewn that agents which alter the specific gravity of the

---

[1] Many saline solutions which on this theory might be expected to act endosmodically, have, however, a purgative action quite independent of any mechanical quality, and are purgative when injected into the veins.

[2] Liebig, *Lancet*, June 8th, 1844.

[3] *London Medical Gazette*, New Series, vol. i. for the Session 1844–5, pp. 753, 836, and 849. Also, *Guy's Hospital Reports*, Rees and Lane, *On the Anatomy of the Blood Corpuscle*, Oct. 1841, 79, and 1842, p. 317.

liquor sanguinis exert an influence on the blood corpuscles, by affecting the endosmotic currents through their membranes: agents which increase the specific gravity of the liquor sanguinis collapse the corpuscles, while those which lessen the specific gravity distend them. Water injected into the jugular vein of the dog caused rapid distension of the corpuscles, and rupture of their membrane.

But alterations in the specific gravity of the liquor sanguinis are produced not merely by substances added to the blood, but by agents which influence the action of the secreting organs. Thus hydragogues, diuretics, and sudorifics, by removing water from the system, increase the specific gravity of the serum, and thus indirectly give rise to physical alteration of the blood corpuscles.

Alterations in the specific gravity of the liquor sanguinis, and of the condition of the blood-corpuscles, are probably attended with important effects in the animal economy. Thus Dr. Rees observes that, when the corpuscles are enlarged by distension, they are precluded the possibility of entering tubes of the same calibre as before, and thus they may exert a mechanical plugging action on the mouths of bleeding vessels. Moreover, when their contents are more dilute than usual, their endosmotic action on the chyle is lessened, and thus "genesis and the nutrition of the corpuscles is interfered with, and is totally deranged."

The effects of medicines on the blood corpuscles have been particularly noticed by Schultz;[1] but he ascribes the effects to alterations in the vital condition of the corpuscles.

5. The particles of medicinal substances, while contained in the blood, may, perhaps, exercise their endosmotic influence on the parenchyma of organs through the coats of the capillary vessels; and by more or less modifying the phenomena of endosmose and exosmose, by which, in the state of health, the nutrition and repair of organs are effected, must produce important effects in the animal economy. Alcohol in the blood, says Poiseuille, tends to produce depletion of organs to the gain of the sanguineous mass. Do the phenomena of drunkenness depend on this effect, or rather do they result from this effect and the peculiar action of alcohol penetrating our tissues? Water and ammonia, which, says Poiseuille, relieve drunkenness, may, perhaps, do so by producing an effect opposite to that of alcohol. He also suggests that the deleterious action of hydrochlorate of morphia may depend on its opposing the phenomena of endosmose and exosmose which, in the normal state, are continually going on in the interior of organs. Furthermore, he does not think it improbable that the poisonous effects of sulphuretted hydrogen may be due to the opposition which this agent makes to the ulterior phenomena of endosmose and exosmose in organs.

The endosmotic currents going on through a membrane between two liquids, lessen, and ultimately stop, owing to the membrane becoming saturated with the liquids which moisten it. But, by displacing the liquid layers in contact with it by agitation, or by substituting other kinds of liquids, the currents proceed again actively. Founded on this fact, Poiseuille suggests that the *tolerance* of remedies, on which so much stress has been laid by the Italian schools, may be due to the contact of the same substance with the membranes of the digestive tube, which, in consequence, becomes unfitted for transmitting the same quantity of fluid into the blood.

2. CHEMICAL EFFECTS.—In consequence of the mutual affinities which exist between some medicines and the constituents of the tissues and of the blood, numerous and important chemical effects are produced in the animal economy. The *halogenous bodies*, some of the *combustible metalloids*, the *acids*, the *alkalies*, *metallic salts*, *tannin*, *creasote*, and *alcohol*, act in this way.*

a. The *halogenous bodies* (chlorine, bromine, and iodine,) abstract hydrogen and unite with bases. Indirectly they sometimes become oxidizers by taking hydrogen from water and setting free the oxygen. In some cases they may, perhaps, combine directly with organic substances.

---

[1] *Natürliches System der allgemeinen Pharmakologie nach dem Wirkungsorganismus der Arzneien*. Von Dr. C. H. Schultz Schultzenstein, 1846.

Iodine, when applied to the epidermis, produces a brown stain, owing to the formation of ioduretted hydriodic acid. After its internal use, it is found in the urine in the form of hydriodic acid and iodide; and perhaps in that of iodate also.[1]

The antiseptic and disinfecting properties of the halogenous bodies depend probably on some of the chemical actions above alluded to.

β. The *non-metallic combustibles* (sulphur and phosphorus) combine with both oxygen and hydrogen.

Sulphur, taken into the stomach, is thrown out of the system in the urine in the form of sulphuric acid and sulphuretted hydrogen.

Phosphorus is thrown out of the system in the form of phosphorus acid, and, perhaps, also as phosphoric acid and phosphuretted hydrogen.

γ. The *acids* (sulphuric, nitric, hydrochloric, phosphoric, and acetic,) combine with bases, decompose many salts, and unite with or decompose the organic constituents of the body.

The very dilute acids form, with albumen and fibrin, compounds which are insoluble when an excess of acid is present. To this statement acetic and phosphoric acids are exceptions, as their compounds with albumen and fibrin are very soluble.

The concentrated mineral acids decompose most organic compounds. Some of them act as oxidizers. The yellow stain which nitric acid produces with organic tissues depends on the formation of xantho-proteic acid.

The acids are absorbed into the blood, and are thrown out of the system by the excreting organs, especially by the kidneys, the secretions of which they render preternaturally acid. But, during their passage through the system, they are in combination, and have their acid properties neutralised; for the blood does not lose its alkaline properties by transmitting them; and, in the urine, the acids are found, in part at least, in combination.

δ. The *alkalies* unite with acids, decompose some salts, and combine with or decompose the organic constituents of the body.

They decompose albumen and fibrin, but, unlike most of the acids, they form soluble compounds with these organic substances.

Like the acids, the alkalies enter into combination, are absorbed into the blood, and are thrown out of the system by the excreting organs, especially by the kidneys, the secretions of which they render alkaline. The continued use of alkaline substances sometimes leads to the deposition of the earthy phosphates in the urine.

Dr. Bence Jones states that ammonia, when taken internally, allows its nitrogen to become oxidised, and nitric acid to be formed.

Alkalies promote the passage of fatty matters into the system by forming with them an emulsion, which readily passes through animal membrane.

ε. *Metallic salts.*—Most metallic salts react chemically on the organic tissues, and give rise to the formation of new compounds.

The precise chemical changes produced by the metallic salts in the organic tissues have not been very clearly ascertained. They are presumed to be similar to those produced by the action of the metallic salts on albumen.

A considerable number of these salts occasion, when added to albuminous liquors, precipitates which are soluble in many saline solutions, and frequently also in an excess of the albuminous liquor. These precipitates consist of an organic substance (albumen), and metallic matter (oxide or salt); and are called *metallic albuminates*. In some cases, they appear to be mixtures of two substances; one a compound of albumen with the acid of the salt; the other a compound of albumen with the metallic oxide. Sulphate of copper, nitrate of silver, bichloride of mercury, acetate of lead, and chloride of zinc, are salts to which the preceding remarks are applicable.

---

[1] Dr. G. O. Rees *On the Analysis of the Blood and Urine*, 2d ed. 1845, p. 82.

Most of the metallic salts also combine chemically with solid albumen and fibrine.

The alkaline and earthy salts react chemically on the organic tissues; but the precise changes which they produce have been scarcely investigated.

ζ. *Tannic and gallic acids.*—Tannic acid, in the impure state called tannin, acts on the animal tissues in virtue of its affinity for their constituents. It forms, with albumen and gelatine, compounds which are insoluble in water; and it also combines with fibrin. When taken into the stomach, it unites with the constituents of the epithelium, and of the mucous membrane of the alimentary canal. It becomes absorbed, and is evacuated from the system in the urine.

The state of combination in which tannic acid exists in the blood, and in the urine, has not been ascertained.

Gallic acid, when taken into the stomach, becomes absorbed, and is evacuated from the system in the urine; but the nature of its chemical action on the organism is unknown. Unlike tannic acid, it does not form with gelatine a compound insoluble in water.

η. *Creasote, alcohol, and ether.*—Both creasote and alcohol cause the coagulation of albumen.

Creasote causes the coagulation of the albumen both of the egg and of the serum of the blood; and decomposes the epidermis, the epithelium, and other albuminous tissues. Its chemical influence over animal tissues is further evinced by its powerful antiseptic properties.

The action of alcohol on the albuminous and fibrinous tissues consists essentially in the abstraction of water from them. Hence, the more the alcohol is diluted with water, the feebler is its chemical influence.

Ether is closely related to alcohol. It coagulates the albumen of the egg, but not the albumen of the serum of the blood.

3. VITAL EFFECTS.—The vital effects of medicines are frequently, though not invariably, preceded or accompanied by appreciable physical and chemical changes.

Medicinal agents may either destroy life or modify vital action; in the former cases they become poisons.

Agents which destroy life may also effect the complete destruction of the parts with which they come in contact, as in the case of the substances called corrosives. They produce at the same time *morpholysis* and *biolysis*;[1] that is, they destroy both organisation and life.

Liebig[2] refuses to call these substances poisons. They merely destroy, he says, the continuity of particular organs, and are comparable, in their operation, to a heated iron or a sharp knife.

The modifications in the vital manifestations of the system produced by medicines are of three kinds: augmentation, diminution, and alteration of vital action.

Müller[3] observes that, viewing medicinal substances generally, there can be but three principal modes of action and three classes of agents; viz. *stimulants*, *alteratives*, and *agents destroying organic composition.*

---

[1] C. H. Schultz, *Natürliches System der allgemeinen Pharmakologie*, Berlin, 1846, p. 117.

[2] *Organic Chemistry in its Application to Agriculture and Physiology*, edited by Lyon Playfair, Ph.D. London, 1840.

[3] *Physiology*, translated by Baly, vol. i. p. 57.

Schultz[1] thinks that all the organic effects of medicines may be referred to three kinds of actions; viz. the *anabiotic*, the *biolytic*, and the *agonistic*.[2] The first have an organising tendency, and promote strength: they are produced by wines, tonics, aromatics, &c. The second have a disorganising tendency, and lessen or destroy strength: they are caused by acids, salts, metallic substances, and narcotics. The third are defensive against medicines and diseases which they endeavour to expel from the system: they are induced by acrids and evacuants.

1. Agents which heighten, augment, or increase vital action, are called *stimulants* or *excitants*. Some of them exercise a renovating or restorative influence, and are essential to life. They are the *vivifying* or *vital stimuli* (see p. 8, foot-note). Others, though not essentially renovating, yet, under certain conditions, exert a local, vivifying, and strengthening influence. These are called by Müller[3] *homogeneous stimuli*. They are the true tonics. "They exert a vivifying influence when their action on the organic matter favours the production of the natural composition of the parts." Lastly, others have no renovating or vivifying influence; and their continued action on the body is followed by exhaustion. These are termed by Müller *heterogeneous stimuli*.

2. Agents which directly lower or lessen excitability are termed *sedatives* or *contra-stimulants*. Cold is the most unequivocal sedative.

3. Agents which are neither mere stimulants nor mere sedatives, but which effect some alteration in the nature or quality of vital action (probably by producing some change in the composition of the organic tissues), are called *alterants* or *alteratives*. Nearly the whole of the articles comprising the materia medica belong to this group. This alterative action of medicines appears to have been entirely overlooked by the founder of the *Brunonian theory* and the supporters of the *doctrine of contra-stimulus*.

α. Brunonian Theory.

Dr. John Brown[4] assumed that man and other animals possess a peculiar property, termed *excitability*, by which they are distinguished from inanimate bodies. The agents which support life he termed *exciting powers*; and these, acting upon the *excitability*, maintain life; in the language of Brown, they produce the effect called *excitement*. The exciting powers, being stimulant in their nature, are called *stimuli*. They are of two kinds: universal and local. When they are in due proportion, *health* is produced: when they act with too great energy, they exhaust the excitability, and cause *indirect debility*: when with too little, they produce *direct debility*.

Diseases arise from either excessive or deficient excitement: in the first case they are called *sthenic*; in the second, *asthenic*. Remedies are stimuli; some acting with more, others with less, energy than is suited to health; the former are fitted for asthenic diseases, and are called *stimulant* or *sthenic remedies* (*e. g.* animal food, caloric, wine, spirit, musk, ammonia, camphor, and opium); the latter for sthenic diseases, and are called *debilitating* or

---

[1] *Op. supra cit.*

[2] *Anabiotic*, from ἀναβιόω, to revive; *biolytic*, from βίὸς, life: and λύω, to loosen or unbind: *agonistic* (ἀγωνιστικὸς), from ἀγών, a combat or conflict.

[3] *Physiology*, translated by Baly, vol. i. p. 59.

[4] *The Works of Dr. John Brown*, by Dr. W. C. Brown, Lond. 1804.

anti-sthenic (*e. g.* bleeding, cold, low diet, vomiting, purging, sweating, and rest).

According to this doctrine, all medicines are stimuli, and differ from each other in the degree in which they exert their stimulant power: moreover, they are supposed to cause exhaustion by producing previous over-excitement.

Considered in a therapeutical point of view merely, the following objections present themselves to this theory:—

1. Many agents produce exhaustion without previously occasioning any obvious over-excitement (as the respiration of sulphuretted hydrogen or hydrocyanic acid gases).

2. Medicines differ from each other in something more than the degree of their power. If we compare together the effects of foxglove, ammonia, hydrocyanic acid, cinchona, mercury, alcohol, elaterium, and opium, the truth of this remark will be obvious.

3. The great majority of medicines act neither as stimulants nor sedatives merely; they alter the quality of the vital actions: and this alterative effect has been quite overlooked by the Brunonians.

β. Doctrine of Contra-stimulus.

(New Italian Doctrine.)

This doctrine is a modification of the preceding. It was advanced about the commencement of the present centuary by Rasori and Borda, and was subsequently adopted by Tommasini and some other distinguished Italian physicians.

It admits *two* classes of medicines: the one called ***stimulants*** or ***hypersthenics;*** the other, *contra-stimulants* or *hyposthenics*. The first exalt, the second depress, the vital energies. Hence this doctrine obviates one of the objections to the hypothesis of Brown, since it admits the existence of agents possessing a positive power of reducing vital action.

Contra-stimulants obviate or counteract the effects of stimulants. Thus wine being universally admitted to be a stimulant, those agents which relieve the inebriation produced by it are denominated contra-stimulants. Reasoning thus, the supporters of this doctrine deny that purgatives stimulate the stomach or intestines; for though they evacuate the contents of the alimentary canal, yet their general effects are depressing. If it be objected, that their continued use causes inflammation, it is answered that the same effect is produced by the most powerful contra-stimulant—cold; and they account for it by ascribing it to reaction, which, though a consequence of contra-stimulus, is not directly caused by it. But, by the same process of reasoning, it would not be difficult to show that some of the substances which the Italian physicians denominate stimulants (as opium) are really contra stimulants, since they are frequently useful in relieving excitement. Indeed, the supporters of this doctrine are by no means agreed among themselves as to the stimulant or contra-stimulant quality of certain medicines; for some of them regard cinchona as belonging to the class of stimulants, while others rank it among the contra-stimulants.

It will be obvious, from the preceding remarks, that the supporters of the doctrine of contra-stimulants disregard, or overlook, the physiological effects of medicines, and direct their sole attention to the secondary effects or consequences, which are uncertain, and often accidental: for many of the agents denominated contra-stimulants do not always, or even frequently, relieve excitement, but often have the contrary effect. The founders of this doctrine, therefore, have assembled under the same head substances causing the most dissimilar and opposite effects; while they have separated others whose general operation is very analogous. They assume the existence of certain diseases, which they call sthenic, because they are produced by too much stimulus, and admit the existence of contra-stimulants, because certain agents sometimes, or frequently, relieve this state. In other words, they judge of the nature of a disease by the effect of the curative means, and of the virtues of medicines by the nature of diseases. So that if a disease, now supposed to be sthenic, should hereafter prove to be asthenic, the medicines used to relieve it would immediately pass from the class of contra-stimulants to that of stimulants!

But the most important objection to the doctrine of contra-stimulus is, that its supporters have totally overlooked that alterative action which nine-tenths of the most important articles of the materia medica evince. When we attentively watch the effects of medicines, it will become manifest that few of them excite or depress merely. Their most characteristic property is that of changing or altering the quality of vital action; and among the more active of our medicinal agents scarcely two agree in producing the same kind of alteration. This objection to the doctrine of contra-stimulus equally applies to the doctrine of Brown; and appears to me to be fatal to both hypotheses.

The supporters of the doctrine of contra-stimulus assert that the doses of contra-stimulants should be proportioned to the degree of excitement; and that, when inflammatory action runs high, the patient can bear very large doses without any obvious evacuation, the disease being subdued wholly by the contra-stimulant effect upon the solids of the body. This asserted capability of bearing increased doses has been denominated *tolerance*[1] of medicines; and has led to the employment of remedies in much larger doses, and at shorter intervals, than were previously ventured on; and, in the case of emetic tartar, the practice has proved highly successful. But, if the hypothesis were true, the tolerance ought to decrease as the disease declines, which certainly does not hold good with respect to emetic tartar, as will be hereafter mentioned. The truth appears to be, then, that many medicinal substances may be administered with safety, and, in certain maladies, with advantage, in doses which were formerly unheard of; and for this fact we are indebted to the founders of the doctrine of contra-stimulus.[2]

In some maladies, as congestion or inflammation of the brain, large quantities of blood may be abstracted without causing syncope, and not only with impunity, but with benefit. These diseases, therefore, appear to confer a protective influence. On the other hand, in fever, intestinal irritation, dyspepsia, and cholera, the abstraction of a much smaller quantity of blood is attended with syncope; so that these maladies appear to diminish the tolerance of blood-letting. Dr. Marshall Hall has laid great stress on these facts,[3] and has proposed to employ blood-letting as a diagnostic to distinguish irritation from inflammation. Thus when we are doubtful whether a disease is encephalitis or intestinal irritation, he says "we must prepare the arm, open a vein, and then place the patient upright, and let the blood flow until the lips become pallid; if the case be encephalitis, an extreme quantity of blood will flow, even thirty or forty ounces, or more, before there is any appearance of syncope; if it be intestinal irritation, syncope occurs before one-fourth of that quantity of blood has left the circulating system."[1]

---

[1] See p. 96, for a notice of Poiseuille's explanation of the cause of the tolerance of medicines.

[2] For further information respecting the doctrine of contra-stimulus, see *Della Nova Dottrina Medica Italiana, Prolusione alle Lezioni di clinica medica per l'Anno scolastico* 1816–1817, del Professore Tommasini, Firenze, 1817; *Quarterly Journal of Foreign and British Medicine and Surgery*, vol. iv. p. 213, Lond. 1822; *The Edinburgh Medical and Surgical Journal*, vol. xviii. p. 606; and the *Lancet*, vol. ii. for 1837–38, pp. 696, 770, and 862.

[3] *Researches principally relative to the Morbid and Curative Effects of Loss of Blood*, 1830.

Thus assuming *the degree of tolerance in blood-letting in health* to be ℥xv., he says the *augmented tolerance* in congestion of the brain will be ℥xl.—l.; in inflammation of the serous and synovial membranes, ℥xxx.—xl.; in inflammation of the parenchyma of organs, ℥xxx.; and in inflammation of the skin and mucous membranes, ℥xvj. The *diminished tolerance* in fevers and eruptive fevers he fixes at ℥xij.—xiv.; in delirium tremens and puerperal delirium, at ℥x.—xij.; in laceration or concussion of the brain, and in intestinal irritation, at ℥viij.—x.; in dyspepsia and chlorosis, at ℥viij.; and in cholera, at ℥vj.[2]

But though I admit the general fact that some diseases augment while others lessen the tolerance of blood-letting, yet I am by no means prepared to admit all the inferences which Dr. Hall has drawn therefrom. The distinction which he sometimes makes between irritation and inflammation is oftentimes more ideal than real; as when he endeavours to show that the pleurisy caused by broken ribs is rather irritation than inflammation.[3] And, moreover, while we may fairly doubt whether blood-letting is capable of distinguishing inflammation from irritation, the propriety of resorting to so powerful an agent in doubtful cases is fairly questionable, and sometimes highly dangerous. "In my opinion," observes my friend Dr. Billing, "before such a decided step is adopted, the physician ought to have made up his mind as to what is the nature of the disease."[4]

2. *Locality or Seat of the Physiological Effects.*

The physiological effects of medicines take place either in the part to which these agents are applied, or in more or less distant parts. The former are called *local* or *topical effects*; the latter, *remote effects*.

1. LOCAL OR TOPICAL EFFECTS.—Physical, chemical, and vital changes are produced by the topical action of medicines.

Particular medicines appear to act primarily on particular tissues: thus, narcotics on the nerves of the part, acrids or irritants on the capillary blood-vessels, and so on. But an alteration in the condition of one tissue is in general attended with some change in the state of other tissues; and thus agents whose primary action is on the nerves may secondarily affect the capillaries, and, *vice versâ*, those whose influence is first directed to the capillaries may indirectly affect the nerves.

2. REMOTE EFFECTS.—These, like local effects, include physical, chemical, and vital changes.

Of the various remote effects it cannot be doubted that some are the consequences of others: in other words, some are primary or direct, others secondary or indirect. But so close and intimate are the relations which exist between the different organs and functions, that it is frequently difficult, and sometimes perhaps impossible, to distinguish the primary and secondary effects from each other; and it is not improbable that many of the effects now regarded as primary or direct, are, in reality, secondary or indirect. This difficulty is well illustrated in the case of the narcotics whose operation on the nervous system is usually considered to be primary or direct, but which C. H. Schultz[1] considers to be a consequence of a previous change effected in the blood-corpuscles. "Narcotics," he observes, "paralyse the blood-corpuscles, and by these the effect is communicated to the nervous system."

---

[1] *On the Diseases and Derangements of the Nervous System*, p. 352, Lond. 1841.

[2] *Introductory Lecture to a Course of Lectures on the Practice of Physic, delivered at the Medical School in Aldersgate Street*, p. 42, London [1834].

[3] *Lancet*, Nov. 4, 1837; and *Principles of Diagnosis, and of the Theory and Practice of Medicine*, p. 355, Lond. 1837.

[4] *First Principles of Medicine*, p. 67, foot-note, 4th edit. Lond. 1841.

It has been hitherto generally supposed that there were two media by which medicines or poisons affected remote parts: these were, *absorption*, or the passage of medicinal or poisonous molecules into the blood; and *sympathy*, or by an impression transmitted through the nerves.

Sir Benjamin Brodie[2] inferred this double mode of operation from his experiments on several poisons. But it has appeared to some writers improbable that an agent should be capable of affecting remote parts in two ways. "All fair analogy," observe Messrs. Morgan and Addison[3], "forbids the conclusion that a poison or an ordinary cause of disease shall at one time produce constitutional disturbance through the medium of one system of organs, and at another time through the medium of another system of organs." Difficulties, however, have hitherto appeared in the way of an exclusive assumption of either mode of operation; and, therefore, while Magendie, on the one hand, advocated the operation by absorption, and Messrs. Morgan and Addison, on the other hand, that by sympathy, most writers, dissatisfied with these exclusive views, have adopted Sir Benjamin Brodie's opinion. Although late investigations strongly favour, if, indeed, they do not absolutely establish, the correctness of Magendie's opinion, I think it expedient, so long as any doubt remains, to examine both views.

Mechanical violence, corrosives, the sudden impulse of light, heat, cold, electricity, &c. which "operate physically and on the nervous system,"[4] are, strictly speaking, neither medicines nor poisons, and, therefore, are excluded from our present enquiry.

3. *Absorption of Medicines.*

PROOFS.—The operation of medicines and poisons by absorption is proved by the following facts.

1. The disappearance of the medicine or poison from the part to which it was applied.
2. Its detection in a remote part.
    - α. In the blood and chyle.
    - β. In the animal solids.
    - γ. In the excretions.
3. The prevention of its remote effects by the prevention of its circulation.
4. The promotion or retardation of its remote effects by the promotion or retardation of its circulation.
5. The similarity of remote and topical effects.

---

[1] *Natürliches System der allgemeinen Pharmakologie*, p. 172, Berlin, 1846.

[2] *Phil. Trans.* for 1811, p. 178; and for 1812, p. 205.

[3] *An Essay on the Operation of Poisonous Agents on the Living Body*, p. 14, Lond. 1829.

[4] See Dr. Marshall Hall's *Gulstonian Lectures* for 1842, p. 64.

6. The medicinal or poisonous quality communicated to the animal solids and fluids.
7. The occurrence of remote effects after the division of the spinal cord, or of all parts except the blood-vessels.
8. The production of the remote effects by injection of a medicine or poison into the blood.

1. *Disappearance of medicines and poisons from the parts to which they are applied.*—Medicinal and poisonous substances disappear from the alimentary canal, the cellular tissue, and the serous cavities into which they have been introduced. Hence they must have been either decomposed or absorbed.

Drs. Christison and Coindet[1] found that four ounces of a solution of oxalic acid injected into the peritoneal sac of a cat, killed the animal in fourteen minutes. On a post-mortem examination, although none of the fluid had escaped by the wound, they found scarcely a drachm remaining.

2. *Detection of medicines and poisons in remote parts.*—Medicines and poisons have been detected by their sensible qualities (odour, colour, and taste), by their chemical properties, or by their medicinal or poisonous qualities, in parts remote from that to which they were applied.

α. *In the blood and chyle.*—In the blood and chyle, but especially in the former liquid, numerous substances have been detected by Tiedemann and Gmelin,[2] and by other experimenters. The following substances have been detected in the *blood* :[3]—

- Bromine.
- Iodine.
- Lead.
- Copper.
- Mercury.
- Arsenic.
- Silver.
- Tin.
- Iron.
- Antimony.
- Zinc.
- Bismuth.
- Barium.
- Cyanide of potassium.
- Sulphocyanide of potassium.
- Sal ammoniac.
- Nitrate of potash.
- Iodide of potassium.
- Chlorate of potash.
- Sulphuret of potassium.
- Sulphuretted hydrogen.
- Quinine.
- Colouring principle of
  - indigo,
  - rhubarb,
  - madder.
- Hydrocyanic acid.
- Sulphocyanic acid.
- Carbazotic acid.
- Oxalic acid.
- Oil of turpentine.
- Alcohol.
- Camphor.
- Odorous principle of
  - musk,
  - assafœtida.
- Dippel's oil.

Tiedemann and Gmelin administered a variety of colouring, odorous, and saline substances to animals, mixed with their food, and afterwards examined the state of the *chyle*, and of the blood of the (splenic, mesenteric, and portal) veins. Most of them were found in the blood and urine; but none of the colouring or odorous substances could be detected in the chyle, and a few only of the salts were found in it. From these experiments we may conclude, that although saline substances occasionally pass into the chyle, odorous and colouring matters do not: all the three classes of substances, however, are found in the venous blood. These results, observe Tiedemann and Gmelin, are opposed to those obtained by Lister, Musgrave, J. Hunter, Haller, Viridet, and Mattei, but agree with those of Hallé, Dumas, Magendie, and Flandrin.

β. *In the solids* of the body various medicinal substances have been detected; as mercury and the colouring matter of madder in the bones, silver in the brain and skin, lead in the liver, spinal cord, muscles,&c. The following substances have been detected in the *solids* :—

---

[1] *Edin. Med. and Surg. Journ.* xix. 335.

[2] *Versuche über d. Wege auf welchen Substanzen aus dem Magen u. Darmkanal ins Blut gelangen*, Heidelberg, 1820.

[3] The authorities or evidence in support of the above statement will be given hereafter under the head of each substance.

Bromine.
Sulphur.
Mercury.
Silver.
Lead.
Copper
Arsenic.
Antimony.
Ferro-cyanide of potassium.
Alcohol.
Colouring principle of
madder,
indigo,
logwood.

γ. *In the excretions.*—Foreign substances which have been introduced into the circulating mass are separated from the blood, and in this way are got rid of by the excreting organs, especially by the kidneys. Hence traces of medicines or poisons which have been swallowed, or otherwise taken into the system, are usually discoverable in the urine or other secretions.

αα. The most extensive and careful series of experiments made on the passage of foreign substances from the intestinal canal into the *urine* are those of Wöhler[1] and Stehberger.[2] The following substances are mentioned by Wöhler as reappearing in the urine:—

1. *Substances which pass off by the urine unchanged.*

Salts.

Carbonate of potash.
Nitrate of potash.
Chlorate of potash.
Sulphocyanide of potassium.
Sulphuret of potassium (but for the most part decomposed).
Ferrocyanide of potassium.
Silicate of potash.
Tartrate of nickel and potash.
Borax.
Chloride of barium.
Iodide of potassium.

Colouring principles.

Of indigo.
" madder.
" rhubarb.
" gamboge.
" logwood.
" red beet.
" mulberry.
" black cherry.
" bilberry.
" cassia fistula.
Of elder rob.
" cactus opuntia.
" chelidonium majus.
" cistus laurifolius.
" prunes.
Reddish yellow colouring matter of nux vomica bark.
Green fat of turtle.

Odorous principles somewhat altered.

Oil of turpentine.
" juniper.
Of valerian.
" saffron.
" assafœtida.
" garlic.
" castor.
" opium,
" asparagus.
" viola tricolor.

Narcotic principle.

Of amanita muscaria.

Fixed oil.

Of almonds.

2. *Substances which pass in a state of combination.*

Sulphur, as sulphuric acid and sulphuretted hydrogen.
Iodine, as hydriodic acid or iodide.
Oxalic
Tartaric
Gallic
Succinic
Benzoic[3]
acids, appear in combination with an alkali.
Astringency of uva ursi.
" " cinchona.

3. *Substances which pass in a decomposed state.*

Tartrate
Citrate
Malate
Acetate
of potash, or soda, are changed into the carbonate of the same alkali.
Sulphuret of potassium, changed, in a great measure, into the sulphate of potash.
Ferridcyanide of potassium, changed into ferrocyanide of potassium.

Subsequently to the publication of Wöhler's paper, a considerable number of other substances have been detected in the urine, though, in several cases, the state in which they pass out of the system has not been clearly determined. The most important of these substances are as follows:—

Bromine.
Arsenic.
Antimony.
Bismuth.
Lead.
Gold.
Silver.
Tin.
Mercury.
Iron.
Sulphuric acid.
Nitric acid.
Hydrochloric acid.
Phosphoric acid.
Tannic acid.
Meconic acid.
Alum.
Bromide of potassium.
Eau de Javelle.
Quina.
Morphia.
Narcotic principle of
belladonna,
stramonium,
henbane.
Colouring principle of
winter green,
sumach.

---

[1] Tiedemann and Treviranus, *Zeitschrift für Physiologie*, Bd. i. S. 125, 1824.

[2] *Ibid.* Bd. ii. S. 47.

[3] Mr. Ure (*London Medical Gazette*, vol. i. 1840-41, p. 735,) has shown that the urine voided after the ingestion of benzoic acid contains hippuric acid.

In consequence of the general occurrence of poisonous substances in the urine, their detection in this secretion becomes, in cases of poisoning, an important subject of medico-legal research.[1]

ββ. In the *breath*, many volatile substances have been detected by their odour.

Alcohol.
Ether.
Camphor.
Sulphuret of carbon.
Wine.
Turpentine.

Dippel's oil.
Odorous principle of
assafœtida,
garlic,
onions,
vanilla,
cloves.

Odorous principle of
cinnamon,
anise,
fennel,
caraway,
horse radish,
pepper.

Phosphoric fumes (from phosphorus).
Sulphuretted hydrogen (from sulphuret of potassium).

γγ. In the *milk*, a considerable number of substances have been recognised either by their sensible or chemical properties, or by their physiological effects (see p. 107).

Iodine.
Lead.
Zinc.
Bismuth.

Iron.
Mercury.
Carbonate of soda.
Iodide of potassium.

Sulphate of soda.
Purgative principle of senna.
Narcotic principle of opium.

Quina.
Colouring matter of
indigo,
madder.

δδ. In the *cutaneous transpiration*, several medicinal substances have been detected by their odour, colour, or other properties.

Sulphur.
Iodine.
Mercury.

Odorous principle of
musk,
garlic,
onion.

Odorous principle of
assafœtida,
camphor.
Wormwood.

Colouring principle of
indigo.
rhubarb,
saffron.

εε. Both in the *nasal secretion* and in the *tears*, iodine has been detected: in the former case, by its odour; in the latter, by the formation of iodide of mercury on the application of calomel to the eye of a patient to whom iodide of potassium had been administered.[2]

3. *Prevention of remote effects by the prevention of the circulation of medicines and poisons.*—Segalas tied the veins of a portion of intestine, and applied poison, but no effects were produced. Emmert also observed, that when the abdominal aorta was tied, hydrocyanic acid did not give rise to any effect when applied to the foot; but, when the ligature was removed, symptoms of poisoning came on.[3] Lastly, Dr. Blake[4] found, that if a ligature be put around the vena portæ, and then poison be introduced into the stomach, it failed to act.

It deserves notice, that the Academy of Medicine of Philadelphia found that nux vomica, introduced into the intestines, produced tetanus, although the vena porta was tied.[5]

The cardiac orifice of the stomach should be tied to prevent the escape of the poison into the œsophagus. When this precaution is adopted, a ligature placed on the vena portæ prevents the action of poisons introduced into the stomach, as I myself have witnessed.

4. *Promotion or retardation of remote effects by the promotion or retardation of the absorption and circulation of medicines and poisons.*—The remote effects of medicinal and poisonous agents are promoted or retarded

---

[1] Orfila, *Journal de Chimie Méd.* t. viii. 2e sér. 1842, also, *Traité de Toxicologie*, 4me éd. 1843.

[2] Fricke, *Annalen de Pharmacie*, xxiv. 74, 1838.

[3] Müller's *Elements of Physiology*, by Baly, vol. i. p. 242.

[4] *Edinb. Med. and Surg. Journ.* vol. liii. p. 45.

[5] Müller, *op. supra cit.* vol. i. p. 240.

by circumstances which promote or retard absorption. Three of these circumstances deserve separate notice.

α. *Nature of the tissue.*—Nux vomica acts with great energy when applied to the pulmonary surface, with less when introduced into the stomach, and with the least of all when applied to the skin. The same order of gradation is observed with respect to opium. Now, the faculty of absorption or of imbibition, as Magendie calls it, does not take place with equal intensity in all tissues. Certain physical conditions (viz. a fine and delicate structure and great vascularity) enable the pulmonary surface to absorb or imbibe with extreme rapidity: in this respect, indeed, it is not equalled by any tissue of the body. But the membrane lining the alimentary canal absorbs with less facility than the pulmonary membrane, in consequence of its being less vascular, and covered by an epidermoid layer and by mucus, which check absorption: while the cutaneous surface, being invested by an inorganic membrane (the epidermis), does not possess the same physical faculties for absorption met with in either of the foregoing tissues; and hence the comparative inertness of medicines when applied to it. In fact, it is only by the long-continued application of these agents to the skin, or by the removal of the epidermis, that we are enabled to affect the general system.

β. *The physical and chemical properties of medicines.*—The effect of many medicines is in proportion to their solubility. Thus arsenious acid and morphia are both more energetic in solution than in the solid state. Now liquids (particularly those miscible with the blood) are much more readily absorbed than solids. In the treatment of cases of poisoning, we endeavour to take advantage of this fact, and by rendering substances insoluble, diminish their activity, or render them quite inert.

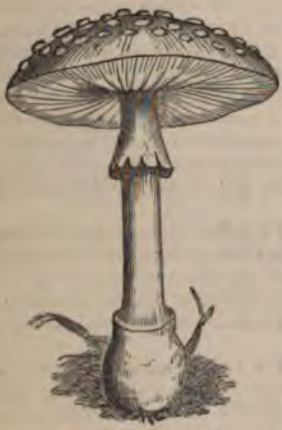
γ. *Condition of system.*—Magendie asserts, as the result of experiments, that plethora uniformly retards, and depletion as constantly promotes, absorption; and, therefore, that when we wish to promote this function, we may do so by blood-letting. Now one means of promoting the action of mercurials on the mouth is to abstract blood; and, in theory, the best means of preventing the operation of poisons is to throw a quantity of warm water into the veins; a practice which Magendie tried on animals, and found successful. Caution, therefore, is recommended in the employment of blood-letting in cases of narcotic poisoning while the poison is in the stomach.

5. *Similarity between the remote and the topical effects.*—The action of a medicine is limited to the part with which medicinal molecules are in contact; but it is not confined to the part to which the medicinal agent was first applied; since by absorption and passage into the blood the molecules may be conveyed to distant parts, on which they may also act. If they are absorbed unaltered, and suffer no change during their passage through the system, their action on remote parts is identical with that on the parts to which they were first applied. But if, in consequence of their contact with the living body, they have undergone chemical change, their action is modified accordingly. Cantharides produce irritation and inflammation of the skin and mucous membranes when applied to those parts; and not unfrequently, in consequence either of their external employment in the form of blister, or of their internal administration, they also produce irritation and inflammation of the bladder and kidneys. The latter effects may be ascribed to the absorption of the cantharidin (the active principle of the insects) into the blood, its passage out of the system by the kidneys, and its action first on the bladder (with the mucous membrane of which it remains for some time in contact) and afterwards on the kidneys, Oil of turpentine, which also irritates and inflames the skin and mucous membranes when placed in contact with them, acts in a similar way on the bladder and kidneys.

6. *Medicinal or poisonous properties of the fluids and solids after the use of medicines or poisons.*—The *milk* is frequently found to have acquired medicinal qualities in consequence of the employment of medicinal

substances by the mother or wet-nurse: it is rendered purgative by senna, emetic by tartarized antimony, narcotic by opium, tonic by quina and other bitters, antacid by alkalies, and anti-syphilitic by mercury.[1] The *urine*, in the same way, sometimes acquires medicinal or poisonous properties. Runge[2] found that the urine of rabbits which had been fed with belladonna, stramonium, and henbane, caused dilatation of the pupil when applied to the eye of another animal. But the most remarkable illustration is that of the *Amanita muscaria* (fig. 7), a fungus employed by many Siberian tribes (the Samoyedes, the Ostiaks, the Toongooses, the Yakutes, the Yookahires, the Koriakes, the Tshooktshes, but especially the Kamtschatdales,) as a substitute for alcoholic liquors to produce excitement and inebriation. It imparts an intoxicating quality to the urine, which continues for a considerable time after taking it. A man, for example, may have intoxicated himself to-day by eating some of the fungus; by the next morning he will have slept himself sober; but by drinking a tea-cupful of his urine, he will become as powerfully intoxicated as on the preceding day. "Thus," says Dr. Greville,[3] on the authority of Dr. Langsdorf, "with a very few *Amanitæ*, a party of drunkards may keep up their debauch for a week;" and "by means of a second person taking the urine of the first, a third of the second, and so on, the intoxication may be propagated through five individuals."

FIG. 7.



Amanita muscaria.

The *blood* of an animal under the influence of poison has been found to possess poisonous properties. Vernière[4] ascertained that if the extract of nux vomica "be thrust into the paw of an animal after a ligature has been tightened round the leg, so as to stop the venous, but not the arterial, circulation of the limb, blood drawn from an orifice in a vein between the wound and ligature, and transfused into the vein of another animal, will excite in the latter the usual effects of the poison, so as even to cause death; while, on the contrary, the animal from which the blood has been taken will not be affected at all, if a sufficient quantity is withdrawn before the removal of the ligature."

Lastly, the *flesh* of poisoned animals has, in some cases, been found to possess deleterious qualities.[5]

---

[1] Dr. Locock, in *The Cyclop. of Pract. Medicine*, art. *Lactation*, states that a patient of Mr. Keate took mercury by giving the nitrate of this metal to an ass, and drinking the milk.

[2] *Mémoire inédit lu à l'Institut.* (Orfila, *Traité de Toxicologie*, 4me éd. t. ii. p. 266). Orfila has repeated Runge's experiments, and denies their accuracy. Dr. Letheby (*Lond. Med. Gaz.* Jan. 22, 1847), however, states that he detected the presence of the active principles of "opium, belladonna, hemlock, aconite," &c. in urine by the effect of this excretion on other animals.

[3] *Memoirs of the Wernerian Natural History Society*, vol. iv. part ii. p. 343, 1823. See also on this subject, Phoebus, *Deutschlands kryptogamische Giftgewächse*, p. 27, 1838; *The History of Kamtschatka and the Kurilski Islands* [by Steller and Krasheninicoff], translated [from the Russian] by Dr. J. Grieve, p. 208, Gloucester, 1764.

[4] *Journal des Progrès des Sciences Méd.* 1827, iii. 121, quoted by Dr. Christison, *Treatise on Poisons*, 4th ed. p. 14.

[5] See on this subject, Christison, *op. cit.* 4th ed. p. 80.

7. *Division of the spinal cord, or of all parts except the blood-vessels, does not prevent the remote effects.*—Some poisons, as hydrocyanic acid, are equally active when applied to the legs of an animal whose spinal marrow has been divided. In this case, the effect of the poison could not be the result of its action on the nerves of sensation and voluntary motion.

It has been objected that the division of the lumbar spine does not prevent the action of poisons by the nervous system, because it does not destroy the action of the excito-motory or sympathetic system, the nervous branches of which are distributed to the lining membrane of the blood-vessels. I am aware that it is an experiment liable to objection; but, on the whole, it is certainly favourable to the opinion of the operation of poisons by absorption; more particularly when we bear in mind that the motion of the blood is necessary to the action of the poison; for if the circulation of a part be obstructed, the poison will no longer act.

Magendie and Delille[1] divided all the parts of one of the posterior extremities of a dog, except the artery and vein, the former being left entire, for the purpose of preserving the life of the limb. A portion of the *upas tieuté* was then applied to a wound in the foot: in the short space of four minutes the effects of the poison were evident; and in ten minutes death took place. It was inferred, therefore, that the poisoning took place by venous absorption.

Several objections have been raised to this inference: first, the exhibition of opium, to diminish the pain of the operation, has been said to vitiate the whole of the experiment; secondly, the coats of the arteries and veins contain lymphatics, by which absorption might be carried on; and thirdly, as the poison was introduced into a wound, the poison might have combined with the blood, and have rendered it deleterious, without the process of absorption taking place. The first two of these objections have been obviated. In a second experiment, Magendie severed the artery and the vein, and reconnected them by quills, so as to preclude the possibility of absorption taking place by the lymphatics: the effects were the same. Some years since I assisted in performing an analogous experiment, using *strychnia* instead of the *upas tieuté*, and without administering opium: death, preceded by the usual symptoms of poisoning, took place in twelve minutes.

8. *Production of remote effects by the injection of medicines or poisons into the blood.*—Medicinal or poisonous agents, injected into the blood-vessels, exert the same kind of specific influence over the functions of certain organs as when they are administered in the usual way; but that influence is more potent. Thus, tartar emetic causes vomiting, castor oil purging, opium stupor, and strychnia convulsions, when thrown into the veins.

RAPIDITY OF ABSORPTION.—Dr. Blake[2] states that the rapidity of the action of a poison is in proportion to the rapidity of the circulation. Thus a substance injected into the jugular vein of a horse arrives at the capillary termination of the coronary arteries in ten seconds; of a dog, in twelve seconds; of a fowl, in six seconds; of a rabbit, in four seconds; and he adds, that the time required for the first symptoms of the poison to present themselves bears a close relation to the rapidity of the circulation. Professor Hering, of Stuttgardt,[3] found that the time which a solution of ferrocyanide of potassium, injected into the jugular vein, requires to reach that of the opposite side, was, in various experiments, from twenty to thirty seconds. And Dr. Blake[4] states that, in dogs, a substance which does not act on the capillary tissue passes from any part of the vascular system back to the same part again in from twelve to twenty seconds. But, rapid as is the circulation of poisonous molecules, it has been supposed not to be sufficiently so to explain the operation of certain poisons which have been said to act instantaneously; and hence an argument has been raised in favour of the nerves being the medium by which the deadly impression is conveyed. To this Dr. Blake[1] replies, that an interval, always more than nine seconds, elapses between the introduction of a poison into the capillaries or veins, and the first symptom of its action;—a period sufficiently long for a poison to be brought into general contact with the tissues it affects.

---

[1] Magendie's *Elementary Compend. of Physiology*, transl. by Dr. Milligan, p. 284, Edin. 1823.
[2] *Lond. Med. Gaz.* for June 18, 1841.
[3] Tiedemann and Treviranus, *Zeitschrift für Physiologie*, iii. p. 122.
[4] *Edin. Med. and Surg. Journ.* vol. liii. p. 42.

ORGANS OF ABSORPTION OF MEDICINES.—The particles of medicinal and poisonous substances are absorbed by the veins principally, but also by the lymphatics and lacteals.

The absorption of these substances by the veins is proved by the following circumstances:—

1. The detection of medicines and poisons in the venous blood (see page 104.)
2. The occurrence of symptoms of poisoning when the poisoned part communicates with the general system merely by the medium of the blood (see page 109.)
3. Magendie states that ligature of the lacteals does not prevent the occurrence of poisoning by agents introduced into the intestines.
4. Ligature of the blood-vessels prevents the occurrence of symptoms of poisoning. (see p. 106).

But absorption is also effected by the lymphatics and lacteals (see p. 104), though it appears to be slow, and confined to certain agents.

MECHANISM OF ABSORPTION OF MEDICINES.—The absorption of medicines consists of two acts; first, their passage through the interstices of the organised tissue with which they are placed in contact, and secondly, their diffusion and circulation.

α. The passage of medicinal substances through organised tisues is effected by imbibition and endosmose, and is exclusively a physical action.

Magendie exposed and isolated the jugular vein of a dog, placed it on a card, and dropped some aqueous solution of the extract of nux vomica on its surface, taking care that the poison touched nothing but the vein and the card. In four minutes the effects of the substance became manifest, and the dog died.[2] It must be admitted, however, that the result of this experiment does not absolutely prove, though it strongly supports, the opinion of the imbibing power of the living vessels: for it might be objected, that the nerves of the venous coats propagated the impression of the poison, and that death took place without absorption; or, that the small veins of the venous coat had taken up the poison. The proof, therefore, should consist in the detection of the poison within the vessel. Now this has been obtained by Magendie: a solution of nux vomica was placed on the carotid artery of a rabbit; but as the tissue of arteries is firmer and less spongy, and their parietes thicker, than those of veins, a longer time elapsed before the poison traversed the vessel. In fifteen minutes, however, it had passed, and on dividing the vessel the blood adherent to its inner wall was found to possess the bitter taste of the poison.

β. The diffusion and circulation of medicinal substances, after they have passed through the coats of the vessels, are effected by the circulating blood, and are physical phenomena.

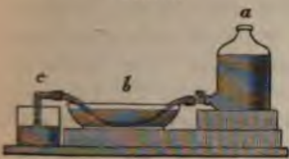
---

[1] *Edinburgh Medical and Surgical Journal*, vol. viii. p. 49.

[2] Magendie, *Lectures*, in the *Lancet*, Oct. 4, 1834.

The following experiment is a physical illustration of both imbibition and circulation of medicinal substances:—If a current of water, coloured by litmus, be allowed to pass through a bottle (fig. 8, *a*), through a vein immersed in diluted sulphuric acid, contained in a glass dish (*b*), into a reservoir (*c*), the litmus liquor is soon observed to become reddened by its passage through the vein, in consequence of the acid permeating the venous coats. If the relative position of the fluids be altered,—that is, the litmus put in the dish (*b*), and the acid passed from the bottle (*a*) through the vein,—the litmus will still become reddened; shewing that the acid has passed, in this case, from within outwards.

FIG. 8.



Apparatus to illustrate Physical Absorption.

Gases and vapours, as well as liquids, readily permeate dead animal membrane. But the same membrane is unequally permeated by different gases.

Although the acts by which the absorption of medicines is effected may be thus regarded as physical, yet vital actions are so far necessary to the process, that they supply the conditions under which the physical phenomena are manifested.

Thus, though dead issues imbibe, and though endosmose takes place through a dead as it does also through a living membrane, yet the vital actions of the heart and lungs are necessary to keep up the circulation of the blood, by which the medicinal molecules are conveyed to distant parts, and the further imbibition and endosmose of the medicine promoted.

ACTION OF MEDICINES SUBSEQUENT TO ABSORPTION.—Medicinal substances, after their introduction into the blood, circulate with this liquor, traverse the capillaries of the various organs of the body, and are ultimately thrown out of the system by the excreting organs. We have, therefore, to consider their action, first, on the blood; secondly, on the tissues of organs; thirdly, on the excreting organs.

1. *Action of medicines on the blood.*—A considerable number of medicinal substances, after their introduction into the circulation, produce changes in the condition of the blood. But neither the precise nature of these changes, nor the particular symptoms which they give rise to, have as yet been accurately determined.

As the living blood consists of two parts, viz. corpuscles, and a clear liquid called plasma or liquor sanguinis, it will be convenient to notice separately the action of medicines on each of these parts.

a. Action of medicines on the blood-corpuscles.—If we assume the blood-corpuscles to be endowed with vitality, we may regard the effects of medicines on them as three-fold; viz. physical, chemical, and vital.

The well-established endosmotic effect of medicines on the blood-corpuscles, and to which I have already had occasion to refer (see p. 95), is an instance of a *physical* effect. Under the influence of certain agents, these bodies become distended, and even burst; while, under the influence of others, they are more or less completely emptied of their liquid contents, and thereby become collapsed, shrivelled, and corrugated.

That *chemical* effects are also produced on the blood-corpuscles can scarcely, I think, be doubted, though it is difficult to adduce unequivocal evidence of this. The alteration produced in the colour of the blood by the action of chalybeates in restoring a healthy vermilion tint to anæmic subjects, must be consequences of chemical changes effected in the contents of the red corpuscles.

The *vital* effects are more obscure than either of the two preceding effects;

and Schultz[1], who is the great advocate of their existence, obviously confounds many physical and chemical effects with them. He believes that the capsule of the corpuscle is an organised structure possessing vitality; and he admits two kinds of vital effects produced on it: the one, which he calls stimulating or anabiotic; the other, paralysing or biolytic (see p. 99). The former are especially produced by the ethereal and aromatic substances; the latter, by water, diluted acids, the haloid substances (particularly iodine), prussic acid, belladonna, and henbane. Medicines, says Schultz, cause biolytic effects by lessening the contractility of the blood-corpuscles; and these are in consequence rendered unfit for respiration, and are incapacitated for firmly retaining the plasma. Water, an important biolytic agent, operates more negatively than positively, since, by diluting the plasma, it lessens the stimulating influence of the dissolved salts on the blood-corpuscles. Salts, on the other hand, strongly excite the corpuscles to contract, and cause them to retain firmly the colouring matter, which, therefore, is not given up to the plasma.

But Dr. Rees, to whose writings I have before had occasion to refer (see p. 95), has clearly proved that the effect of water and saline solutions on the blood is physical, being produced by endosmose.

According to Mialhe,[2] medicines and poisons have four kinds of action on the blood:—

1. Some moderate its course by more or less coagulating its serum, &c.: as nitric acid, creosote, alcohol, the poisonous principle of fungi, metallic salts, &c. The same effect is produced by the precipitation in the blood of insoluble bodies: as the salts of strontian, of lime, of baryta, &c.
2. Some liquefy the blood, and accelerate its course: as the acetates of ammonia, nitrate of potash, the iodides, bromides, &c.
3. Some modify the chemical reactions which take place in this liquid, and which are most frequently effected by seizing its oxygen, a phenomenon which prevents hæmatosis, and produces chlorosis, anæmia, &c.: as is the case with sulphuretted hydrogen, and especially with hydrocyanic acid, which produces instantaneous death in a manner hitherto inexplicable, and which may be ascribed to the catalytic force.
4. Some produce abnormal chemical reactions in it: as the poison of rabid animals, the venom of poisonous serpents, &c. which seem to act in the manner of ferments, whose effects appear to be destroyed by the caustic alkalies, powerful acids, fire, &c.

β. *Action of medicines on the plasma.*—There are, at least, two kinds of effects produced by medicinal and poisonous agents on the blood, which are referable to the action of these substances on the plasma. These are, an alteration in the consistence of the blood, and a change in its coagulability.

In animals poisoned by hydrocyanic acid, as well as by other agents, alterations in the consistence of the blood have been frequently noticed; and it is probable that many medicinal agents produce some effect of the same kind; but our information on this point is very vague and unsatisfactory, owing principally to the difficulty or impossibility of correctly estimating slight changes of consistence.

The coagulation of the blood may be retarded or promoted, and the quantity of fibrin obtained therefrom lessened or augmented, by various medicinal and poisonous agents. Thus the neutral salts and narcotics for the most part retard or prevent the coagulation. It is well known that the addition of nitre or sulphate of soda to fresh-drawn blood impedes the coagulation; and the same effect appears to be produced by administering these salts to living animals. In a case of acute pneumonia in a robust countryman, Schultz abstracted two ounces of blood, a quantity which could have but little, if any, influence on the residual blood in the system. The blood thus abstracted yielded 5 per cent. of fibrin. At the end of twenty-four hours, during which time the patient had taken three drachms of nitre and an ounce of sulphate of soda, two ounces of blood were again drawn; and this portion yielded only 3·4 per cent. of fibrin. The use of the nitre and alkaline sulphate was persevered in, and, at the end of twenty-four hours more, the patient was again bled to the same extent: but this portion of blood yielded only 1·9 per cent. of fibrin. Thus, then, it appears that, under the continued use of these salts, the quantity of spontaneously coagulating matter (fibrin) in the blood progressively lessened. This effect has been termed *anti-plastic* or *plastilytic*. Stimulants, such as the volatile oils and alcohol, have an opposite or *anaplasmatic* effect on the blood; that is, they increase the quantity of spontaneously coagulating matter.

---

[1] *Natürliches System der allgemeinen Pharmakologie*, pp. 155 and 161.

[2] *Traité de l'Art de Formuler*, quoted by Merat, in the *Supplement au Dictionnaire univ. de Mat. Med.* p. 465, 1846.

2. *Action of medicines on the tissues of organs.*—The specific operation of medicines, after their absorption, on particular organs is well known. Thus opium acts on the brain, strychnia on the spinal cord, and so on. Poiseuille has ingeniously attempted to explain some of these effects endosmodically, as I have before stated (see *ante*, p. 96); while Percy, on the other hand, has endeavoured to account for them on chemical principles (see *ante*, p. 91). But neither physics nor chemistry appear to be capable of furnishing a satisfactory explanation of the specific effects of medicines, which, therefore, must be referred, at least for the present, to peculiarities in the vital endowments of particular parts.

Action of medicinal substances on the capillary circulation.—According to the experiments of Poiseuille,[1] it would appear that certain medicines, when introduced into the blood, modify the circulation in the capillaries of living animals. Those which *facilitate* the capillary circulation are, acetate of ammonia, nitrate of potash, sal ammoniac, chloride of potassium, nitrate of ammonia, iodide and bromide of potassium, and most mineral waters (more than forty were tried). The following substances *retard* the capillary circulation:—Alcohol, chlorides of sodium and magnesium, sulphate of ammonia, &c.; sulphuric, tartaric, oxalic, acetic, &c. acids. Water and ammonia counteract the retardation produced by alcohol.

The opposite effects here stated to be produced by the chlorides of potassium and sodium (salts which closely agree in most of their properties), as well as by different salts of ammonia, throw some doubt over the accuracy of these observations, which require to be confirmed by other experimenters.

3. *Action of medicines on the excreting organs.*—Medicinal and poisonous substances, after they have been taken up and conveyed into the blood, are got rid of by the different excreting organs which expel them from the system.

---

[1] *Comptes rendus*, 1843 and 1844.

But the same substances are not thrown out with equal facility by all the excreting surfaces; some showing a preference for one, others for another organ. Thus camphor and alcohol pass out of the system chiefly by the lungs; saline and colouring substances by the kidneys.

The substances which are thus usually thrown out of the system by a certain secreting organ, in general act as stimulants to that organ, and augment its secretion. This is especially the case with the salts which pass out of the system by the kidneys, and which have been long in use as diuretics. We may, therefore, assume that substances which specifically stimulate the kidneys are excreted by these organs; and the same probably holds good with respect to other excreting organs.

The influence which different medicinal substances exercise over the excreting organs, by which they are expelled from the system, is apparently of the same kind as that which the same bodies exercise topically on the parts of the body to which they are first applied (see p. 107).

OBJECTIONS.—The absorption of medicines and poisons has been so fully and satisfactorily proved by numerous experimenters, that the fact is now universally admitted. But it has been denied that this absorption is essential or necessary to the action of these agents on the body. "We must strongly protest," say Messrs. Morgan and Addison, "against the assumption that, because a poison has been found to enter and pass through a vein, it is thence to be inferred that such a process is, under all circumstances, absolutely necessary to its operation." The principal objections which have been raised to the theory of the operation of medicines by absorption are the following:—

1. *The analogy between the effects of injuries and poisons.*—Mr. Travers[1] has forcibly pointed out the analogy observed between the effects of severe injuries and of poisons which operate rapidly on the system; for example, of strychnia and punctured wounds, both of which cause tetanus; and he concludes that their *modus operandi* must, therefore, be identical; and as there is nothing to be absorbed in the one case, so absorption cannot be essential in the other.

But, as Müller[2] has observed, "the fact of two substances producing similar symptoms in one organ does not prove that these substances produce exactly the same effects, but merely that they act on the same organ, while the essential actions of the two may be very different."

2. *The innocuousness of the blood of a poisoned animal.*—Messrs. Morgan and Addison assert that the blood circulating in the carotid artery of a dog poisoned by strychnia, is not poisonous to a second dog; and they, therefore, infer that this poison does not act on the brain by absorption, but by an impression upon the extremities of the nerves.

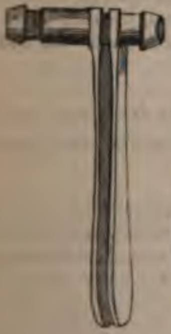
By the aid of a double brass tube (fig. 9), consisting of two short brass cylindrical tubes, to each of which a long handle is attached (fig. 11), they established a complete circulation between the carotids of a poisoned and of a sound dog, by connecting the lower and upper ends of the divided arteries in both animals, so that each supplied the brain of the other with the portion of blood which had previously passed through the carotid artery to his own, and, consequently, the poisoned dog in this case received from the unpoisoned animal a supply of arterial blood equal to that with which he was parting (fig. 11). One of the dogs was then inoculated with a concentrated preparation of strychnia, which had been found upon other occasions to produce death in these animals in about three minutes and a half. In three minutes and a half the inoculated animal exhibited the usual tetanic symptoms which result from the action of this poison, and died in less than four minutes afterwards, viz. about seven minutes from the time at which the poison was inserted, during the whole of which period a free and mutual interchange of blood between the two was clearly indicated by the strong pulsation of the denuded vessels throughout their whole course. The arteries were next secured by ligature, and the living was separated from the dead animal; but neither during the operation, nor subsequently, did the survivor shew the slightest symptom of the action of the poison upon the system.

---

[1] *Further Inquiry concerning Constitutional Irritation.*

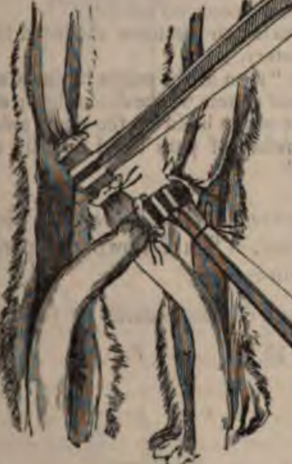
[2] *Essay on the Operation of Poisonous Agents*, p. 56, Lond. 1829.

FIG. 9.



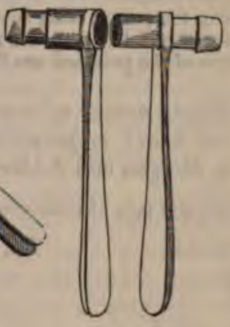
Double Brass Tube.

FIG. 10.



Double Circulation between the Carotids of a poisoned and a sound Dog.

FIG. 11.



Single cylindrical Brass Tubes.

To the conclusions which have been drawn from this experiment it may be replied, first, that other experiments (see p. 108) have shown that the blood of a poisoned animal does possess poisonous properties; and secondly, that the experiment of Messrs. Morgan and Addison is open to several objections.

The objections to this experiment are threefold:—

1. A remarkable error pervades the whole train of reasoning adopted by Messrs. Morgan and Addison, and vitiates some of their conclusions. They assume that Magendie considers actual contact with the brain as essential to the operation of the upas poison.[1] This assumption, however, is not correct. "In 1809," says Magendie,[2] "I laid before the first class of the French Institute, a series of experiments which had conducted me to an unexpected result; namely, that an entire family of plants (the bitter Strychnos) have the singular property of powerfully exciting the spinal marrow, without involving, except indirectly, the functions of the brain." Now it is evident that, in the experiment per-

---

[1] See pp. 42, 43, 47, 49, &c. of the *Essay*.

[1] *Formulaire*, 8me. éd. p. 1.

formed by Messrs. Morgan and Addison, the blood sent from the carotid artery of the poisoned animal to the brain of the sound one could only reach the spinal marrow by the usual route of the circulation; that is, it must be returned by the jugular veins to the heart, from thence to the lungs, back again to the heart; from thence into the aorta, and then distributed through the system. Now it is not too much to suppose that, during this transit, some portion of the poison might be decomposed, or thrown out of the system before it could arrive at the spinal marrow: and even if this were not the case, this organ could only receive a small quantity of the poison contained in the system; namely, that sent by the vertebral to the spinal arteries. Hence we ought to expect that a poison thrown into the arteries will operate less powerfully than when thrown into the veins, unless it be into the arteries supplying the parts on which the poison acts. Moreover, as an anonymous reviewer [Sir David Barry ?] has observed,[1] it is to be recollected, that as the carotid artery, in its healthy state, is little more than one-fourth of the calibre of the vessels carrying blood directly to the brain, the dog not inoculated consequently was subject to the influence of one-fourth only of the quantity of the poison which was conveyed to the *brain alone* of the inoculated animal.

2. It is probable, I think, that the circulation of the blood through the tube was not so free as through the undivided artery.

3. Dr. Blake[2] asserts, that as "soon as the poison begins to exert its influence on either animal, the pressure in its arterial system will be diminished; and thus, far from the blood containing the poison being sent to the brain of the sound animal, the only effect of the arrangement will be to cause a reflux of pure blood from the arteries of the sound dog into those of the poisoned one."

3. *Rapid action of a poison notwithstanding that its direct entrance into the heart is prevented.*—The following experiments were made by Messrs. Morgan and Addison:—

The jugular vein of a full-grown dog was secured by two temporary ligatures; one of which was tied round the upper, and the other round the lower part of the exposed vein. The vessel was then divided between these two ligatures, and the truncated extremities reconnected by means of a short brass cylinder or tube (fig. 13), within which was placed a portion of woorara, of the size of a grain of canary-seed (fig. 12). Both the temporary ligatures were then removed (fig. 14), the accustomed circulation through the vessels was re-established, and in forty-five seconds the animal dropped on the ground, completely deprived of all power over the muscles of voluntary motion: in two minutes, convulsions and respiration had entirely ceased. This result was to be expected, whatever theory be adopted.

FIG. 12. FIG. 13. FIG. 14.

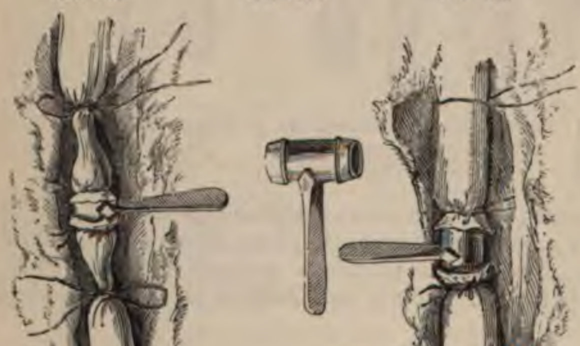


Fig. 12. The divided vein reconnected by a brass tube, containing poison. The ligatures not yet removed.
Fig. 13. Brass-connecting-tube containing the poison.
Fig. 14. Ligatures loosened.

---

[1] *Lond. Med. and Phys. Journ.* vol. lxiii.

[2] *Edinb. Med. and Surg. Journ.* vol. liii. p. 48.

In another experiment two temporary ligatures were applied to the jugular vein, as in the former case. A cylinder of quill, containing a little woorara, was introduced into the vein between the two ligatures; another ligature was then applied (fig. 15), and the upper temporary ligature removed (fig. 16). In the space of 108 seconds after the removal of the ligature, the animal dropped in convulsions, as in the former case, and expired in 3¼ minutes. Now, in this experiment, the direct entrance of the poisoned blood into the heart, &c. was prevented by the lower ligature; hence, if the poison operated by contact with the brain, a greater length of time was necessary for its effects to be produced; inasmuch as the circulation was no longer going on through the trunk of the jugular itself, and, therefore, if the poison acted by actual contact, it must have got into the system by the vessels of the vein.

FIG. 15.

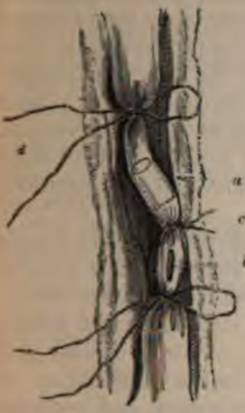


FIG. 16.

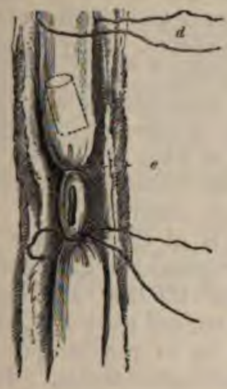


Fig. 15. *a*, Cylinder of quill containing poison, introduced into the vein by the aperture, *b*; the ligature, *c*, being afterwards applied. The ligature, *d*, not yet removed.

Fig. 16. Ligature, *d*, unloosened; *e*, remaining.

This experiment, however, cannot be regarded as conclusive. For although the "result is certainly different from what might have been anticipated, on the supposition of the circulation of the poison in the blood being essential to its action, yet we cannot regard it as a conclusion against that supposition, unless it were shown that the poison, when the ligature above it is removed, and when it mingles itself with the stream of blood in the vein, does not taint this blood as far back as the next anastomosing branches, and so make its way forward to the heart. That this is not the effect of removing the farther ligature is not shown by these authors; and their other experiments in favour of their peculiar doctrine of the mode of action of poisons, we have no difficulty in pronouncing to be inconclusive."[1] Moreover, the poison may act by diffusion.[2]

4. *Operation of Medicines by Nervous Agency.*

A considerable number of remedial agents operate physically on the body, and affect remote parts through the agency of the nervous system. The most important of these are—electricity, heat, cold, light, mechanical irritants, and corrosives.

Several of the irritant gases produce spasmodic closure of the larynx when an attempt is made to inhale them in the pure and undiluted state. Chlorine, hydrochloric acid gas, ammonia, and carbonic acid, excite this effect. As these substances possess very different chemical properties, while they produce an effect on the glottis which is also produced by mechanical irritation, it is probable that their action is physical. The fit of asthma which is sometimes brought on by inhaling the dust of ipecacuanha is, perhaps, excited in the same way. The great depression of the heart's action which the corrosives occasion when they are swallowed, is similar to that caused by wounds or rupture of the stomach, intestine, or gall-bladder, or to the mechanical violence done to a limb in the case of accidents. They act on the principle of shock.[1] "All those substances," says Liebig,[2] "which produce the direct destruction of the organs with which they come into contact, may be compared to a piece of iron, which can cause death by inflicting an injury on particular organs, either when heated to redness, or when in the form of a sharp knife. Such substances are not poisons in the limited sense of the word, for their injurious action depends merely upon their condition."

---

[1] See a criticism in *The British and Foreign Medical Review*, vol. v. for Jan. 1837.

[2] For some remarks on the diffusion of substances introduced into the blood, see Matteucci's *Lectures on the Physical Phenomena of Life*, pp. 352–3. Lond. 1847.

The agents whose operation is of the kind here referred to affect remote parts by the agency of the true spinal and ganglionic systems. The mode of action of those which act through the true spinal system is excited and reflex; that is, an impression is made on, and carried by, the incident excitor nerves to the nervous centre, which, by its peculiar power, affects a remote part through the medium of its reflex motor nerves. The mode of operation of those agents which act through the ganglionic system is excited, and, perhaps, may also be reflex.

Medicines and poisons, properly so called, were formerly supposed to act, not by absorption, but through the agency of the nervous system. In the present state of our knowledge, however, this notion is quite untenable: for while the evidence adduced in favour of the opinion that medicines operate in consequence of absorption almost amounts to absolute demonstration, the arguments in favour of the sympathetic action of these agents are few, feeble, and of doubtful validity. The experiments of Dr. Blake, some of which I have already (p. 109) had occasion to notice, appear to me to have given the *coup-de-grâce* to the latter hypothesis.

Of the various circumstances which have been adduced in favour of the sympathetic action of medicines, two only deserve to be noticed. They are—

1. The velocity of operation of some poisons.
2. The limited nervous transmission of local impressions produced by certain medicinal agents.

1. The velocity of operation of some poisons (*e. g.* hydrocyanic acid, conia, &c.) has been thought to be incompatible with any other mode of operation but that by nervous impression.

Dr. Blake[3] has met this argument by declaring that poisons are not instantaneous in their action, but that sufficient time always elapses between the application of a poison and the first symptom of its action, to admit of its contact with the tissue which it affects. Thus he found, that after half a drachm of concentrated hydrocyanic acid had been poured on the tongue, eleven seconds elapsed before any morbid symptom appeared, and death did not occur until thirty-three seconds after the exhibition of the poison; and on repeating Dr. Christison's experiment, he found that fifteen seconds elapsed after ten drops of conia (saturated with hydrochloric acid) had been injected into the femoral vein of a dog, before symptoms of the action of the poison appeared; and death did not occur until thirty seconds after the injection. Now the time required for a substance to be absorbed by the capillaries, and diffused through the body, may not exceed, according to Dr Blake, nine seconds. So that the interval which elapsed in the preceding experiments, between the application and the effect, is quite sufficient to admit of the absorption and diffusion of the poison (see *ante*, p. 109).

---

[1] Dr. Marshall Hall's *Gulstonian Lectures* for 1842, p. 67.

[2] Liebig's *Organic Chemistry in its Application to Agriculture and Physiology*, edited by Lyon Playfair, Ph.D. 2d edit. p. 353, Lond. 1842.

[3] *Edinb. Med. and Surg. Journ.* vol. liii. p. 35.

2. "It is maintained," says Dr. Christison,[1] "that a limited nervous transmission,—that is, the conveyance of a local impression, purely functional in its nature, to parts at a short distance from the texture acted on directly,—must occur in some instances; as, for example, in the action of belladonna in dilating the pupil when applied to the conjunctiva of the eye, and in the effect of opium in allaying deep-seated pain when applied to the integuments over the affected part."

But this, in reality, is no argument. The dilatation of the pupil produced by the application of belladonna to the conjunctiva, or even to the temples, is a fact which may be explained as well by vascular as by nervous agency.

5. *Circumstances which Modify the Effects of Medicines.*

The circumstances which modify the effects of medicines may be arranged under two heads; those relating to the medicine, and those relating to the organism.

1. RELATING TO THE MEDICINE.—Under this head are included—

a. State of Aggregation.—The state of aggregation of a medicine modifies the effect. Thus morphia is more active in solution than in the solid state.

b. Chemical Combination.—The soluble salts of the vegetable alkaloids are more active than the uncombined alkalies; and *vice versâ*, the insoluble salts are less active. Lead and baryta are rendered inert by combination with sulphuric acid.

c. Pharmaceutical Mixture.—The modifications produced by medicinal combinations have been very ably described by Dr. Paris.[2] The objects to be obtained, he observes, by mixing and combining medicinal substances, are the following:—

OBJECT I.—*To promote the action of the basis or principal medicine*:—

- α. By combining the several different forms or preparations of the same substance.
- β. By combining the basis with substances which are of an analogous nature, *i. e.* which are individually capable of producing the same or kindred effects.
- γ. By combining the basis with substances of a different nature, and which do not exert any chemical influence upon it, but are found, by experience, or inferred by analogy, to be capable of rendering the stomach, or system, or any particular organ, more susceptible of its action.

OBJECT II.—*To correct the operation of the basis, by obviating any unpleasant effects it might be likely to occasion, and which would pervert its intended action, and defeat the object of its exhibition.*

- α. By chemically neutralising or mechanically separating the offending ingredient.
- β. By adding some substance calculated to guard the stomach or system against its deleterious effects.

---

[1] *Treatise on Poisons*, 4th ed. 1845, p. 7.

[2] *Pharmacologia*, 9th edit. p. 373, *et seq*. 1843.

Object III.—*To obtain the joint operation of two or more medicines.*

- . By uniting those substances which are calculated to produce the same ultimate results, but by modes of operation totally different.
- β. By combining medicines which have different powers, and which are required to obviate different symptoms, or to answer different indications.

Object IV.—*To obtain a new and active remedy not afforded by any single substance.*

- α. By combining medicines which excite different actions in the stomach and system, in consequence of which new or modified results are produced.
- β. By combining substances which have the property of acting chemically upon each other; the results of which are—
    - *a.* The formation of new compounds;
    - *b.* The decomposition of the original ingredients, and the development of their more active elements.
- γ. By combining substances, between which no other chemical change is induced than a diminution, or increase, in the solubility of the principles in which their medicinal virtues reside.
    - *a.* By the intervention of substances that act chemically.
    - *b.* By the addition of ingredients whose operation is entirely mechanical.

Object V.—*To afford an eligible form.*

- α. With reference to its efficacy.
- β. With reference to its taste or appearance.
- γ. With reference to its consistence or equable mixture.
- δ. With reference to its preservation.

d. Organic peculiarities.—Vegetables have their medicinal properties considerably modified by the nature of the soil in which they grow, by climate, by cultivation, by age, and by the season of the year when gathered.

e. Dose.—The modifications produced in the effects of medicines by differences of dose are well seen in the case of opium, mercurials, and turpentine.

2. Relating to the Organism.—Under this head are included several circumstances, of which the most important are the following:—

a. Age.—The effects of medicines are modified by the age of the individual. Thus children are more susceptible than adults; and, as a general rule, it may be stated that the dose should be augmented in proportion to the number of years that the patient is old. But this rule does not apply to very aged persons, who require smaller doses than adults in the prime of life.

Gaubius, Young,[1] and Hufeland,[2] have each laid down rules for the adaptation of the doses of medicines to different ages. But no general rule is of much practical value, since there must be numerous exceptions to it, on account of the different susceptibilities to the influence of different medicines being unequal at the same age. Thus infants are peculiarly susceptible of the influence of opium, and to them this medicine must either not be exhibited at all, or at least with extreme caution. But the case is far otherwise with respect to calomel and some other medicines.

The following posological table for different ages is a translation of the one contained in the Pharmacopœia of Guy's Hospital, and is more extended than any other which I have met with.

---

[1] *Introduction to Medical Literature*, p. 453, 2d edit. Lond. 1823.

[2] *Lehrbuch der allgemeinen Heilkunde*, p. 84, 2te Aufl. Jena, 1830.

AGE.	MAXIMUM DOSE.		
	One Ounce. ℥j.	One Drachm. ʒj.	One Scruple. ℈j.
Months.			
1	ʒss.	gr. iij.	gr. j.
3	—	iv.	—
6	℈ij.	vj.	ij.
9	—	vij.	—
Years.			
1	ʒj.	viij.	iij.
2	ʒjss.	x.	iv.
3	ʒjss.	xij.	
4*	ʒij.	xv.	v.
5	ʒijss.	xviij.	vj.
6	ʒiij.	xx.	vij.
7	ʒiijss.	xxv.	viij.
8*	℥ss.	ʒss.	℈ss.
10	ʒivss.	gr. xxxv.	gr. xij.
12	ʒv.	xl.	xiv.
13	ʒvss.	—	xv.
15	ʒvj.	xlv.	xvj.
18	ʒvjss.	—	xvij.
20	ʒvij.	l.	xviij.
21 to 45*	℥j.	ʒj.	℈j.
50	ʒvij.	gr. l.	gr. xviij.
60 to 70	ʒvj.	xlv.	xvj.
80 to 90	ʒv.	xl.	xiv.
100*	℥ss.	ʒss.	℈ss.

b. Sex.—The sex has an influence on the operation of medicines. Females possess greater susceptibility of the nervous system, more excitability of the vascular system, and less energy or power, than males; and medicines act on them more rapidly, powerfully, and for a shorter period, than on males. In these respects, indeed, they approach children. Hence, therefore, medicines should be administered in smaller doses, and at somewhat shorter intervals, than to men.

The periods of menstruation, pregnancy, and lactation, are attended with peculiarities in relation to the action of medicines. Drastic purgatives should be avoided during these states, especially during the two first. Agents which become absorbed, and thereby communicate injurious qualities to the blood, are to be avoided during pregnancy and lactation.

c. Mode of life: Occupation.—These circumstances affect the susceptibility of the whole organism, or of different parts, to the influence of external agents.

d. Habit.—The habitual use of certain medicinal or poisonous agents, especially narcotics, diminishes the influence which they ordinarily possess over the body. Of the truth of this statement we have almost daily proofs in confirmed drunkards, in chewers and smokers of tobacco, and in opium-eaters. Instances of the use of enormous doses of opium, with comparatively slight effects, are found in every work on pharmacology. One of the most remarkable which I have met with is that related by G. V. Zeviani.[1] A woman of the name of Galvani, during a period of thirty-four years, took more than *two cwt.* of solid opium !! When nineteen years old she fell down stairs, and divided her urethra by a knife. Although the wound healed, she was unable to pass her urine in the usual way, but vomited it up daily with excruciating pain, to relieve which she resorted to the use of opium, the doses of which were gradually increased to 200 grains daily.

---

[1] *Sopra un Vomito Urinoso*, in the "*Memorie di Matematica e Fisica della Società Italiana.*" Verona, t. vi. p. 93, 1792–4.

The influence of acrid or irritating substances is but little diminished by repetition,—a remark which applies especially to bodies derived from the mineral kingdom.

Several attempts have been made to account for the effect of habit. Some ascribe it to an increased power acquired by the stomach or tissues of decomposing the medicinal agent.[1] Müller,[2] on the other hand, attributes a great number of the instances of habituation to the organ becoming saturated with the medicine, while it remains susceptible of other agents. But a strong objection to this hypothesis is, that the effect of habit is observed principally in the case of vegetable narcotics, and is scarcely perceived in the case of inorganic substances which have the most powerful affinities for the constituents of the animal tissues. The same physiologist ascribes part of the phenomena observed in the effects of habit to the excitability of the organ being deadened by the stimulus being too often repeated.

e. Diseased Conditions of the Body.—Diseases of various kinds sometimes have a remarkable influence in modifying the effects of medicines—a fact of considerable importance in practice. Two of the best known instances of this are the diminished influence of opium in tetanus, and of mercury in fever.

Begin[3] has endeavoured to explain the diminished influence of opium in tetanus, by assuming that the stomach acquires an increase of assimilative power. But Mr. Abernethy[4] found thirty drachms of solid opium undissolved in the stomach of a man who died from traumatic tetanus, and to whom opium was given in enormous doses during life. Moreover, Begin's hypothesis would not explain the diminished influence of mercury in fever.

f. Climate.—The well-known influence of climate in modifying the structure and functions of the animal economy, and in promoting or alleviating certain morbid conditions, necessarily induces us to ascribe to it a power of modifying the effects of medicines. But it is difficult to obtain pure and unequivocal examples of it, in consequence of the simultaneous presence and influence of other powerful agents.

g. Mind.—The effects of medicines are very much modified by the influence of the mind. Hufeland[5] knew a lady who, having conceived a violent aversion to clysters, was thrown into convulsions by the injection of a mixture of oil and milk. I have known the most violent effects attributed to bread pills, which the patients had been previously informed exercised a powerful influence over the system. Much of the success obtained by empirical practitioners depends on the confidence which patients have in the medicines administered.

h. Race.—Differences of race have been supposed to give rise, in some cases, to differences in the action of medicines on the body. Thus Charvet[6] ascribes to this circumstance the different effects of opium on the Javanese and Malays (both belonging to the Mongolian race) as compared with those produced on Europeans, Turks, and Persians (the Caucasian race). "The Javanese," says Lord Macartney,[1] "under the influence of an extraordinary dose of opium, becoming frantic as well as desperate, not only stab the objects of their hate, but sally forth to attack, in like manner, every person they meet, till self-preservation renders it necessary to destroy them." A similar account is given by Raynal[2] of the effects of opium on the Malays.

---

[1] Christison's *Treatise on Poisons*, pp. 31 and 35, 4th edit. 1845.

[2] *Physiology*, by Baly, p. 60.

[3] *Traité de Thérapeutique*, t. i. p. 113, Paris, 1825.

[4] *Lancet*, vol. v. 1824, p. 71.

Op. cit. p. 80.

[6] *De l'Action comparée de l'Opium*, p. 59, Paris, 1826.

i. Temperaments.—Temperament also modifies the influence of medicines on the system. The phlegmatic temperament is less susceptible of the influence of remedies than the choleric, the sanguine, and the melancholic. In the sanguine temperament, stimulants are to be employed very cautiously; in the nervous temperament, evacuants are to be used with great care.

k. Idiosyncrasy.—The influence of idiosyncrasy in modifying the effects of medicines and poisons is, in general, to increase their activity. Thus, some individuals are peculiarly susceptible of the action of opium, others of mercury, and some of alcohol. The dust or odorous emanation of ipecacuanha, in certain persons, produces short and difficult respiration, like that of asthma. The late Mr. Haden[3] has related a case in which two drachms and a half of tincture of colchicum produced death: the mother of the patient was also exceedingly susceptible of the action of colchicum, even in very small doses. In some instances, however, the effect of idiosyncrasy is to diminish the activity of the medicines. Thus some persons are exceedingly insusceptible of the action of mercury.

l. Tissue or *Organ.*—The nature of the part to which a medicine is applied has an important influence over the effect produced. The stomach, for example, is much more susceptible of medicinal impressions than the skin. Opium acts more powerfully when applied to the serous than to the mucous tissues. Carbonic acid operates as a positive poison when taken into the lungs, but as a grateful stimulant when applied to the stomach. The modifications effected in the action of medicines by the differences of tissue or organ depend partly on the relative rapidity of absorption, and partly, perhaps, on the unequal degree of decomposition which these agents undergo in different tissues.[4]

5. THERAPEUTICAL EFFECTS OF MEDICINES.

The effects produced on diseases, by the influence of medicines, are denominated *therapeutical.* They are sometimes termed *secondary,* because, in a great majority of instances, they are subordinate to those already described under the name of physiological.

MODE OF PRODUCTION.—Therapeutical effects are produced in two ways:—

1. *Sometimes medicines remove or destroy the exciting causes of disease,* when these are still acting, and are material and cognizable. They do this by either a direct or indirect influence.

a. When they act *directly,* they are termed by Hufeland[5] *specifica*

---

[1] *Embassy to China,* vol. i. pp. 263–4, Lond. 1792.

[2] *Histoire Philosophique et Politique des Deux Indes,* t. 1er p. 359, Genève, 1780.

[3] Dunglison's *Translation of Magendie's Formulary,* with Notes by C. T. Haden, Esq. p. 98, 4th edit. Lond. 1825.

[4] See Christison *On Poisons* 4th edit. pp. 30-31.

[5] *Op. supra cit.* p. 78

qualitativa. Antidotes which render poisons inert, and agents which destroy intestinal worms or cutaneous parasites, act in this way.

β. Some of them act *indirectly;* as emetics given to dislodge a biliary calculus, or purgatives to remove irritating matters from the alimentary canal.

2. In a large majority of instances, however, the causes of disease have ceased to act; or, if still acting, are either not cognizable, or, if cognizable, are not of a material nature. In all such cases we administer medicines to alter diseased action. The agents which we employ for this purpose operate either directly or indirectly.

α. They act *directly* when their particles come in contact with the diseased part, either by immediate application to it, as in the case of unguents, lotions, gargles, collyria, injections, and other topical agents; or by absorption, and through the medium of the circulation, as when we employ the turpentines in gleet and leucorrhœa.

β. They act *indirectly* when their influence is exerted directly on some other part, and through this indirectly on the seat of the disease. The beneficial effects of purgatives in cutaneous and cerebral diseases, of diuretics in dropsies, of opium in allaying spasm of the intestinal canal or in checking diarrhœa, and of blisters in intestinal diseases generally, are obtained in this way.

In all these cases, we explain the therapeutic effect by assuming that a new kind of action is set up in the part affected, by which the previous morbid action is superseded; and that the new action, or artificial disease, subsides when the use of the medicine is suspended or desisted from.

FUNDAMENTAL METHODS OF CURE.—According to the homœopathists, there are only three possible relations between the symptoms of diseases and the specific effects of medicines—namely, *opposition, resemblance,* and *heterogeneity.* It follows, therefore, that there are only three imaginable methods of employing medicines against disease; and these are denominated *antipathic, homœopathic,* and *allopathic.*

1. *Antipathia.*—The *antipathic* (so called from ἀντί, *opposite,* and πάθος, *a disease*), *enantiopathic,* or *palliative* method, consists in employing medicines which produce effects of an opposite nature to the symptoms of the disease; and the axiom adopted is "*contraria contrariis opponenda.*" Though this principle was admitted in several ancient schools, yet it was explained and carried out at different periods in very different ways. Thus Hippocrates, who may be regarded as the founder of this doctrine, observes,[1] that "all diseases which proceed from repletion are cured by evacuation; and those which proceed from evacuation are cured by repletion. And so on in the rest; contraries are the remedies of contraries." The Methodists also adopted it, though in a different sense, when they treated the *strictum* by relaxing agents, and the *laxum* by astringents. The Galenists, likewise, were antipathists, since they employed hot remedies to combat cold diseases, and treated moist maladies by dry remedies.

We adopt this practice when we employ purgatives to relieve constipation; depletion to counteract plethora; cold to alleviate the effects of scalds; narcotics to diminish preternatural sensibility or pain; opium to check diarrhœa; and astringents to combat relaxation.

---

[1] *Aphorismi,* Section 2nda.

The homœopathists object to antipathic remedies, on the ground that, though the primary effects of these agents may be opposite to the phenomena of a disease, the secondary effects are similar to them. "Constipation excited by opium (primitive effect) is followed by diarrhœa (secondary effect); and evacuations produced by purgatives (primitive effect) are succeeded by costiveness, which lasts several days (secondary effect)."[1] But the beneficial influence of numerous antipathic remedies (*e. g.* opium in diarrhœa) is too well established to admit of doubt.

2. *Homœopathia.*—The *homœopathic* (so called, from ὅμοιος, *like* or *similar*, and πάθος, *a disease*,) method of treating diseases consists in administering a medicine capable of producing effects similar to the one to be removed, and the axiom adopted is "*similia similibus curantur.*"

Hahnemann's first dissertation on homœopathy was published in 1796, in Hufeland's Journal.[2] In 1805 appeared his "*Fragmenta de viribus medicamentorum positivis.*" But the first systematic account of this doctrine appeared in 1810, in a work entitled "*Organon der rationellen Heilkunde.*"

The following, says Hahnemann, are examples of homœopathic cures performed unintentionally by physicians of the old school of medicine:—

The author of the fifth book, Ἐπιδημιῶν, attributed to Hippocrates, speaks of a patient attacked by the most violent cholera, and who was cured solely by white hellebore; which, according to the observations of Forestus, Ledelius, Reimann, and many others, produces of itself a kind of cholera. The English sweating sickness of 1415, which was so fatal that it killed 99 out of 100 affected with it, could only be cured by the use of sudorifics. Dysentery is sometimes cured by purgatives. Tobacco, which causes giddiness, nausea, &c., has been found to relieve these affections. Colchicum cures dropsy, because it diminishes the secretion of urine, and causes asthma in consequence of exciting dyspnœa. Jalap creates gripes; therefore it allays the gripes, which are so frequent in young children. Senna occasions colic; therefore it cures this disease. Ipecacuanha is effectual in dysentery and asthma, because it possesses the power of exciting dysentery and asthma. Belladonna produces difficult respiration, burning thirst, a sense of choking, together with a horror of liquids when brought near the patient; a flushed countenance, eyes fixed and sparkling, and an eager desire to snap at the bystanders; in short, a perfect image of that sort of hydrophobia which Sir Theodore de Mayerne, Münch, Buchholz, and Neimicke, assert they have completely cured by the use of this plant. When, indeed, belladonna fails to cure canine madness, it is attributable, according to Hahnemann, either to the remedy having been given in too large doses, or to some variation in the symptoms of the particular case, which required a different specific—perhaps hyoscyamus, or stramonium. Drs. Hartlaub and Trinks have subsequently added another homœopathic remedy for hydrophobia—namely, cantharides. Opium cures lethargy and stupor, by converting it into a natural sleep. The same substance is a cure for constipation. Vaccination is a protection from small-pox, on homœopathic principles. The best application to frost-bitten parts is cold, either by the use of some freezing mixture, or by rubbing the part with snow. In burns or scalds the best means of relief are the exposure of the part to heat, or the application of heated spirit of wine or oil of turpentine.

---

[1] Hahnemann, *Organon*, § lxi.

[2] See the *Preface to the English Translation of the "Organon."*

Hahnemann thinks that it is of little importance to endeavour to elucidate, in a scientific manner, how the homœopathic remedy effects a cure; but he offers the following as a probable explanation. The medicine sets up, in the suffering part of the organism, an artificial but somewhat stronger disease, which, on account of its great similarity and preponderating influence, takes the place of the former; and the organism from that time forth is affected only by the artificial complaint. This, from the minute dose of the medicine used, soon subsides, and leaves the patient altogether free from disease; that is to say, permanently cured. As the secondary effects of medicines are always injurious, it is very necessary to use no larger doses than are absolutely requisite, more especially as the effects do not decrease in proportion to the diminution of the dose. Thus eight drops of a medicinal tincture do not produce four times the effects of two drops, but only twice: hence he uses exceedingly small doses of medicines. Proceeding gradually in his reductions, he has brought his doses down to an exiguity before unheard of, and seemingly incredible. The millionth part of a grain of many substances is an ordinary dose; but the reduction proceeds to a billionth, a trillionth, nay, to the decillionth of a grain, and the whole materia medica may be carried in the waistcoat-pocket!

The following is the method of obtaining these small doses:—Suppose the substance to be a solid; reduce it to powder, and mix one grain of it with ninety-nine grains of sugar of milk: this constitutes the *first attenuation*. To obtain the *second attenuation*, mix one grain of the first attenuation with a hundred grains of sugar of milk. The *third attenuation* is produced by mixing one grain of the second attenuation with ninety-nine grains of sugar of milk. In this way he proceeds until he arrives at the *thirtieth attenuation*. Water is the diluent for liquid medicines. The following table shows the strength of the different attenuations, with the signs he employs to distinguish them:—

Attenuations.	*Parts of a Grain.*	*Attenuations.*	*Parts of a Grain.*
1. First	One-hundredth.	V. Fifteenth	One-quintillionth.
2. Second	One-thousandth.	VI. Eighteenth	One-sextillionth.
I. Third	One-millionth.	VII. Twenty-first	One-septillionth.
II. Sixth	One-billionth.	VIII. Twenty-fourth	One-octillionth.
III. Ninth	One-trillionth.	IX. Twenty-seventh	One-nonillionth.
IV. Twelfth	One-quadrillionth.	X. Thirtieth	One-decillionth.

Here is a tabular view of the doses of some substances employed by the homœopathists:—

Charcoal, one or two decillionths of a grain.
Chamomile, two quadrillionths of a grain.
Nutmeg, two millionths of a grain.
Tartar emetic, two billionths of a grain.
Opium, two decillionths of a drop of a spirituous solution.
Arsenious acid, one or two decillionths of a grain.
Ipecacuanha, two or three millionths of a grain.

These doses are given in pills (*globuli*), each about the size of a poppy-seed. Hahnemann gravely asserts, that the length of time a powder is rubbed, or the number of shakes we give to a mixture, influences the effect on the body.

Rubbing or shaking is so energetic in developing the inherent virtues of medicines, that latterly, says Hahnemann, "I have been forced, by experience, to reduce the number of shakes to two, of which I formerly prescribed ten to each dilution."[1] In mixing a powder with sugar, the exact period we are to rub is, therefore, laid down; and in dissolving a solid in water, we are told to move the phial "*circa axin suam*," and at each attenuation to shake it *twice*—"*bis brachio quidem bis moto, concute*."[2]

The principal facts to be urged against this doctrine may be reduced to four heads:—

1st. Some of our best and most certain medicines cannot be regarded as homœopathic: thus substances which destroy the itch insect (Acarus Scabiei), and thereby cure the itch, are incapable of producing this malady. Andral took quina in the requisite quantity, but without acquiring intermittent fever; yet no person can doubt the fact of the great benefit frequently derived from the employment of this agent in ague; the paroxysms cease, and the patient seems cured. "But," says Hahnemann, "are the poor patients really cured in these cases?" All that can be said is, that they seem to be so; but it would appear, according to this homœopathist, that patients do not know when they are well. We are also told that, whenever an intermittent resembles the effects of cinchona, then, and not till then, can we expect a cure. I am afraid, if this were true, very few agues could be cured.

2dly. In many cases homœopathic remedies would only increase the original disease; and we can readily imagine the ill effects which would arise from the exhibition of acrids in gastritis, or of cantharides in acute inflammation of the bladder, or of mercury in salivation.

3dly. The doses in which these agents are exhibited are so exceedingly small, that it is difficult to believe they can produce any effect on the system,[3] and we may infer that the supposed homœopathic cures are referable to a natural and spontaneous cure, aided, in many cases, by a strict attention to diet and regimen. What effect can be expected from a decillionth part of a drop of laudanum, or a millionth of a grain of charcoal? Hahnemann says, it is foolish to doubt the possibility of that which really occurs; and adds, that the sceptics do not consider the rubbing and shaking bestowed upon the homœopathic preparation, by which it acquires a wonderful development of power!

4thly. Homœopathy has been fairly put to the test of experiment by some of the members of the *Académie de Médecine*, and the result was a failure. Andral tried it on 130 or 140 patients, in the presence of the homœopathists themselves, adopting every requisite care and precaution, yet in no one instance was he successful.[4]

3. *Allopathia.*—The *allopathic* (so called from ἄλλος, *another*, and πάθος, *a disease*,) or *heteropathic* method consists in the employment of medicines which give rise to phenomena altogether different or foreign (neither similar nor exactly opposite) to those of the disease.

Under this head is included that mode of cure effected by what is called *antagonism* or *counter-irritation*; that is, the production of an artificial or secondary disease in order to relieve another or primary one. It is a method of treatment derived from observation of the influence which maladies mutually exert over each other. For example, it has been frequently noticed, that if a diarrhœa come on during the progress of some internal diseases, the latter are often ameliorated, or perhaps rapidly disappear, apparently in consequence of the secondary affection. The result of observations of this kind would naturally be the employment of alvine evacuants in other analogous cases where diarrhœa did not spontaneously take place: and this practice is frequently attended with beneficial results. The appearance of a cutaneous eruption is sometimes the signal for the disappearance of an internal affection; and *vice versâ*, the disappearance of a cutaneous disease is sometimes followed by disorder of internal organs. Here we have another remedy suggested, namely, the production of an artificial disease of the skin, as by blisters, by an ointment containing emetic tartar, or by other irritating applications,—a suggestion, the advantage of which experience has frequently verified. I might bring forward numerous other examples to prove the fact (which, however, is so well known as to require little proof), that morbid action in one part will often cease in consequence of a morbid action taking place in another. Diseases, then, appear to have what Dr. Pring[1] calls a *curative relation* with respect to each other; and we shall find that the greater part of our most valuable and certain remedies operate on the principle of antagonism or counter-irritation; that is, they produce a secondary disease which is related to the primary one. Dr. Parry[2] calls this the "*cure of diseases by conversion.*"

---

[1] *Organon.*

[2] See Dr. Quin's *Pharmacopœia Homœpathica.*

[3] The statements of the homœopathists with regard to the effects of medicines are truly absurd and ridiculous. In the French edition of Hahnemann's Materia Medica, no less than forty-five octavo pages are devoted to the statement of 720 symptoms produced by the one-millionth of a grain of vegetable charcoal, and of 190 symptoms caused by the like quantity of animal charcoal. Among the many effects ascribed to these agents we find "itching of the internal angle of the left eye," "itching in a wart on the finger," "repugnance for butter," "obstruction of the left nostril for an hour," "speedy loss of appetite by eating," &c. &c. Many of the observations are filthy and obscene.

[4] See *Medical Gazette*, vol. xv. p. 922.

Mr. Hunter says, he has seen bubo cured by an emetic. Now, it is very improbable that the benefit arose from the mere evacuation of the contents of the stomach. The only plausible explanation to be offered is, that the emetic sets up a new action in the system, which was incompatible with that going on in the groin. If this notion be correct, emetics act as counter-irritants. The efficacy of purgatives, in affections of the head, is best accounted for by supposing that they operate on the principle of counter-irritation. Blisters, cauteries, issues, moxa, and other remedies of this kind, are generally admitted to have a similar mode of operation. Even the efficacy of blood-letting, in inflammatory affections, is better explained by assuming that this agent induces some new action, incompatible with the morbid action, than that it is merely a debilitant. The immediate effect sometimes produced on disease, by this remedy, is so remarkable as hardly to admit of the supposition of its acting as a mere weakening agent. One full blood-letting will sometimes put an immediate stop to ophthalmia; and I have seen, even while the blood was flowing, the vascularity of the eye diminish, and from that time the disease progressively declined. When to this fact we add, that the same disease is often successfully treated by other different, and even opposite remedies, such as mercury and stimulant applications, we find a difficulty in explaining their beneficial agency, except by supposing that they influence disease by some relation common to all of them. This view of the counter-irritant operation of blood-letting is supported by Dr. Clutterbuck,[3] Dr. Pring,[4] and others.

Revulsion and *derivation* are both cases of counter-irritation: in the first, the artificial or secondary disease is produced in a part remote from the seat of the primary affection; in the latter, the artificial disease is set up in the neighbourhood of the primary malady. For example, leeches or blisters applied to the feet in apoplexy are called revulsives; but the same applications to the head, in the same disease, would be termed derivatives. There is, however, no real distinction between them, their operation being similar; for revulsion is only derivation at a distant part.

---

[1] *An Exposition of the Principles of Pathology*, p. 352, *et seq.* Lond. 1823.

[2] *Elements of Pathology and Therapeutics*, 2d edit. 1825.

[3] *Lectures on the Theory and Practice of Physic*, published in the *Lancet*, vol. x. 1826.

[4] *Op. cit.* pp. 465–8.

Topical applications are frequently counter-irritants. Thus, stimulant washes, applied to the eye, sometimes cure ophthalmia. They operate, apparently, by altering the morbid action, and substituting a milder and more easily cured disease for the one previously existing.

Using the term counter-irritation in its most extended sense, we see our list of agents producing this effect is a most extensive one. It comprehends emetics, purgatives, diffusible stimulants, mercury, blisters, cauteries, issues, setons, moxa. blood-letting (including arteriotomy, venesection, cupping, and leeches), irritating lavements, frictions, sinapisms, rubefacients, the hot and cold baths, and even mental impressions. That is, all these agents excite some action in the system which has a relation (oftentimes beneficial) to the morbid action: to use Dr. Parry's words, these agents cure diseases by *conversion*.

The most unsatisfactory part of the subject is, the theory or hypothesis of the manner in which the mutual relations of diseased actions are effected. Dr. Parry presumes that most diseases consist in local determinations of blood, and that it is a law of the human constitution that excessive morbid determination to two different parts shall not exist in the same person at the same time. Neither of these assumptions, however, is quite correct; but, if both were true, they still leave untouched the question, how determination of blood to one organ is cured by producing a determination to another. To account for it, some assume that the system can produce only a certain quantity of nervous energy, and that as, in every disease, there is an undue or preternatural distribution of nervous energy, so the production of an artificial disease in one part must, by consuming the nervous energy, diminish the disease in another. But the whole hypothesis is grounded on assumptions perfectly gratuitous and incapable of proof. As Dr. Pring justly observes, were this hypothesis true, it would lead us to employ, not bleeding, purgatives, blisters, and all indirect remedies in hepatitis or consumption, but the exercise of the treadmill for a few hours; so that a patient, labouring under phrenitis or pneumonia, should be made to walk fifteen or twenty miles a day, by which, it would be presumed, so much nervous energy would be consumed in the arms and legs, that there could not possibly be any preponderance or excess in any other seat.

Discarding all hypotheses, we must, for the present, be content with the knowledge of the fact, that one disease, whether artificially or spontaneously generated, will often, but not invariably, supersede another of a different kind.[1]

a. The *antagonisms* of determinations of blood and of the secretions have been before referred to.[2] Müller[3] states that the antagonism of the secretions is subject to the following laws:—

1. The increase of a secretion in a tissue, *a*, which is less irritable than the organ, *b* is incapable of producing a diminution in the secretion of the latter; hence, for example, artificially excited secretions from the skin, as by a blister, in the neighbourhood of the eye, in inflammation of the latter organ, are of no service, because the eye is a more irritable part than the skin.

---

[1] For further information on this subject, consult Hunter's *Treatise on the Blood, Inflammation, and Gun-shot Wounds*, Lond. 1794; *Dict. des Sciences Médicales*, art. *Révulsion*, by MM. Pinel and Brichetean; *Dict. de Médecine*, art. *Derivatif*, by Guersent; J. C. Sabatier, *Les Lois de la Révulsion, étudiées sous le Rapport Physiologique et Thérapeutiqne*, Paris, 1832.

[2] See p 12.

[3] *Elements of Physiology*, by Baly, vol. . p. 473–4.

2. An increased secretion in a certain tissue, *a*, cannot be diminished by exciting the same secretion in another part of the same tissue, *a*; on the contrary, such a procedure would rather increase the secretion from all parts of the tissue than diminish it, because the relation which exists between the different parts of one and the same tissue is that of sympathy, not of antagonism. Hence a discharge from the generative or urinary organs cannot be arrested by an artificially excited diarrhœa.

3. On the contrary, the secretions of tissues which do not belong to the same class of structures often antagonise each other. Thus, increase of the cutaneous secretion frequently induces diminution of the secretion of the kidneys: in summer, the cutaneous exhalation is more abundant, and the urinary secretion proportionally scanty; in winter, the reverse is the case. Effusion of watery fluids into the cellular membrane and serous cavities is attended with dryness of the skin, and diminution of the urinary secretion, the quantity of which is observed to increase in the same proportion as dropsical effusions diminish. Suppression of the exhalation of the skin by cold, gives rise to mucous discharges from the intestinal and pulmonary mucous membranes.

4. It is only towards the termination of consumptive diseases that this relation of antagonism between the secretion ceases to exist; when, in consequence of the relaxed state of the tissues, all are at length increased in quantity; in the colliquative state that precedes death in phthisical patients, colliquative diarrhœa, profuse sweating, and dropsical effusions, take place simultaneously.

5. When one tissue is excited to increased action, by an impression made upon another, either the secretion of the two must have been in some respects similar as in the case of the skin and kidneys, both of which have the office of excreting water from the blood; or the organ thus excited must have had a predisposition to morbid action, which is the rational explanation for the circumstance that the impression of cold produces in one person an affection of the mucous membrane of the lungs; in another, a disordered secretion of mucus in the intestinal canal.

6. PARTS TO WHICH MEDICINES ARE APPLIED.

Medicines are applied to the skin; to mucous or serous membranes; to wounds, ulcers, or abscesses; or they are injected into the veins.

1. *Applications to the Skin.*

Medicinal applications are frequently made to the skin in order to produce local effects, as in the case of blisters, cataplasms, fomentations, lotions, embrocations, &c.; and occasionally to affect remote parts of the system, as when we use mercury. Most, if not all, medicines which influence distant organs by application to the skin, do so in consequence of their absorption; and, as the cuticle offers a mechanical impediment to this process, we generally either remove it or make use of friction.

There are three methods of applying medicines to the skin; namely, the *enepidermic*, the *iatraleptic*, and the *endermic*.

1. THE ENEPIDERMIC METHOD consists in the application of medicines to the skin, unassisted by friction; as when we employ plasters, blisters, poultices, lotions, fomentations, baths, &c.

2. THE IATRALEPTIC METHOD (which has been so called from ιατρεύω, *I cure* or *heal*, and ʽαλείφω, *I anoint*), consists in the application of medicines to the skin, aided by friction. It has been termed the *epidermic method*—sometimes *anatripsologia* (from ἀνατρίβω, *I rub in*, and λόγος, *a discourse*), and also *espnoic medicine*. It was employed by Hippocrates, and other old writers; but fell into disuse, until attention was again drawn to it by Berera, Chiarenti, Chrestien,[1] and others. Among the substances which have been

---

[1] *De la Méthode Iatraleptique*, Paris, 1811.

employed in this way are camphor, digitalis, squills, cantharides, disulphate of quina, veratria, colocynth, rhubarb, opium, belladonna, mercury, chloride of gold, &c.

The mode of employing medicinal agents, according to the iatraleptic method, is the following: the substance to be applied being reduced to the finest possible state of division, is to be dissolved or suspended in some appropriate liquid, and in this state rubbed into the skin. The dose is always considerably larger than for the stomach—generally two or three, often as much as ten, and, in some cases, even twenty times the ordinary dose: but no absolute rule on this head can be laid down. The liquids employed to dissolve or suspend the medicine may be water, spirit, or oily or fatty matter. Iatraleptic writers, however, prefer the gastric juice, or saliva, or even bile; but I am not acquainted with any just grounds for this preference. Collard de Martigny[1] concludes from his experiments, that the palms of the hands, soles of the feet, neighbourhood of the joints, the chest, the back, and the inner parts of the limbs, are to be preferred for the application of medicines.

The objections to this mode of employing medicines are the uncertainty of results; the time required to affect the system; the frequently unpleasant nature of the process (as when mercurial inunctions are employed); and the local irritation sometimes produced by the friction. Notwithstanding these, however, it may be resorted to occasionally with advantage; as where the patient cannot or will not swallow, or where the alimentary canal is either very irritable or insensible to the action of medicines.

3. THE ENDERMIC, or EMPLASTRO-ENDERMIC METHOD, consists in the application of medicinal agents to the denuded dermis. For its introduction into practice we are indebted to MM. Lembert and Lesieur.[2]

The denudation of the dermis is usually effected by a blistering plaster. When the cuticle is elevated, an opening is to be made into it, in order to allow the serum to escape. The medicine is then applied to the dermis, either with or without removing the cuticle. At the first dressing, the transparent pellicle formed by the dermis is to be carefully removed, as it very much impedes absorption. The medicine is applied to the denuded surface, either in its pure state, in the form of an impalpable powder—or if too irritating, it is to be incorporated with gelatine, lard, or cerate. Should any circumstances arise to lead us to fear that the quantity of the medicine applied has been too large, the mode of proceeding is the following:—Cleanse the surface immediately; make compression (as by a cupping-glass) around the denuded part, in order to prevent absorption, and apply any substance that will neutralize the effect of the medicine. Thus, Lembert has found, that two grains of the acetate of morphia will destroy the tetanic symptoms caused by the application of two grains of strychnia, Musk and camphor are said to counteract the narcotism of morphia.[3]

Instead of a blistering plaster, Trousseau recommends a vesicating ointment, composed of equal parts of a strong solution of ammonia and lard. Two applications of five minutes each are sufficient to raise the cuticle. Boiling water, which has been employed by some persons, is uncertain, painful, and dangerous: it may cause mortification of the dermis, and thus stop absorption.

---

[1] *Dict. de Médec. et de Chirurg. pratiq.* art. *Iatreleptie.*

[2] *Essai sur la Méthode Endermique*, par A. Lembert.

[3] Ahrensen, *Dissert. de Methodo Edermatico*, Hauniæ, 1836—Reviewed in the *Brit. and Foreign Med. Review*, for April 1838, p. 342.

The advantages of the endermic method are, that substances are not submitted to the influence of the digestive process, and their pure effects can be better ascertained;—their operation is in general very quick, and in some cases more rapid than when they are applied to the stomach. If the gastric membrane be inflamed, or if the patient cannot (or will not) swallow, more especially if the case be urgent, this is an admirable method of putting the system under the influence of a medicine.

The disadvantages of the endermic method are, the pain sometimes experienced by the application of medicinal agents to a denuded surface—some even may occasion mortification of the part; the possibility of the skin being permanently marked; lastly, some substances have no effect when used endermically.

The substances which have been used by this method are morphia and its acetate, hydrochlorate, and sulphate, in doses of from a quarter of a grain to two grains; strychnia, from a quarter of a grain to a grain; aconitina, one-sixteenth to one-eighth of a grain; extract of belladonna, three or four grains; disulphate of quina, two to six grains; musk, six or eight grains; tincture of assafœtida, ten minims. Many other agents have also been employed endermically: as digitalis, extract of squills, aloes, saffron, bichloride of mercury, emetic tartar, &c.[1]

Method by Inoculation.—In connection with the endermic method may be mentioned another method of employing medicines, namely, the method by inoculation proposed by M. Lasargue de St. Emilion.[2] In this way morphia has been employed to relieve topical pain. It is introduced in the part in pain by the point of a lancet. In a few minutes a pimple and an erythematous blush are produced.

2. *Applications to the Mucous Membranes.*

We have two mucous membranes, to the different parts of each of which we apply medicines: the first is *the gastro-pulmonary membrane*, the second *the urino-genital.*

1. *Gastro-pulmonary Membrane.*

a. Ocular mucous membrane (conjunctiva).
b. Nasal or pituitary membrane.
c. Bucco-guttural membrane.
d. Eustachian membrane.
e. Aërian or tracheo-bronchial membrane.
f. Gastro-intestinal membrane.
g. Recto-colic membrane.

2. *Urino-genital Membrane.*

a. Urethro-vesical membrane.
b. Vagino-uterine membrane.

1. GASTRO-PULMONARY MEMBRANE: *a. Ocular mucous membrane* or *conjunctiva.*—Medicines are applied to the conjunctiva, to excite local effects only, though we might employ this part for other purposes, since remote organs may be affected by it. The term *collyrium* (κὸλλύριον) formerly

---

[1] For further information on the endermic method, consult, besides Lembert's Essay before quoted, the article *Méthode Endermique*, by Bouillaud, in the *Dict. de Médec. et Chirurg. pratiques*; also some articles, by Dr. Bureaud Riofrey, in the *Continental and British Medical Review*, vol. i. pp. 66, 321, and 385; and Richter, in *Lond. Med. Gaz.* Nov. 10, 1838.

[2] See the *Continental and British Review*, vol. i. pp. 41 and 388; and *Lancet*, for 1836–37, vol. i. p. 826.

employed to indicate solid substances applied to the eyes, now usually means liquid washes for the eyes, and is equivalent to *eyewater*.

b. *Nasal* or *pituitary membrane*.—We seldom apply medicines to the *pituitary* membrane except in affections of the nose or adjacent parts. Sometimes they are employed to irritate and excite a discharge; they are then called *errhines*; but when used to produce sneezing, as when foreign bodies are in the nasal cavities, they are termed *sternutatories* or *ptarmics*.

c. *Bucco-guttural mucous Membrane*.—Medicines are very rarely applied to the *mouth* and *throat*, except for local purposes. It however has been proposed to excite salivation by rubbing calomel into the gums. Solids used in the mouth are termed *lozenges* (*trochischi*) or *masticatories*, according as they are allowed to dissolve slowly or are masticated; liquids are called *collutoria* or *gargarismata*. Powders are introduced by insufflation.

d. *Eustachian Membrane*.—Aurists now and then apply washes to the *Eustachian tubes* in local affections; but the occasions for this practice are rare, and the operation difficult, except in practised hands.

e. *Aërial* or *tracheo-bronchial Membrane*.—Accidental observation, as well as experiment, has shown that medicines produce very powerful effects on the membrane lining the *trachea* and *bronchial tubes*. Applications to these parts are in general made use of for local purposes, as in asthma, chronic bronchitis, phthisis, &c., though occasionally to affect the brain, the blood, the heart, &c. Dr. Myddleton[1] advocated the inhalation of substances (as cinchona, sulphate of iron, myrrh, &c.) reduced to an impalpable powder, in pulmonary diseases. The fumes (*suffitus*) of tar, balsam, resins, and other burning bodies, have also been employed in these cases.[2]

The inhalation of aqueous vapour (*halitus*), either alone or with other substances, is oftentimes useful in various affections of the lungs and of the throat, &c. The apparatus generally used for this purpose is Dr. Mudge's inhaler, or it may be that proposed by Dr. Gairdner.[3] In the absence of these, a teapot, or basin with an inverted funnel, is often employed; but in many asthmatic cases the difficulty of breathing is so great, that the patient cannot close the mouth around the tube, especially if the latter be small, without exciting a sense of impending suffocation. In such instances I have found the only easy and practical method of enabling the patient to inhale, is by holding the mouth over hot water contained in a basin or teacup. Various narcotic and emollient herbs are sometimes added to the water, but I suspect without contributing in any way to its efficacy. (The methods of inhaling oxygen, chlorine, and nitrous oxide gases, and the vapours of sulphuric ether, iodine, bromine, &c. will be described hereafter.)

f. *Gastro-intestinal Membrane*.—We employ both extremities of the *alimentary canal* for the exhibition of medicines; the upper, however, more frequently than the lower. This mode of employing medicines is called the *method by ingestion*. Of all parts of the body, the gastro-intestinal surface is the most useful for the application of medicines. This arises from the great susceptibility, the active absorbing power, and the numerous relations which the stomach has with almost every part of the body. In many cases remote effects are more easily produced by this than by any other organ, as in the case of diffusible stimulants. Medicines which act by absorption are more energetic when applied to the serous membranes, the bronchial membrane, the cellular tissue, &c. In some cases it is not only possible, but probable, that the stomach may either partially or wholly digest a medicine.

---

[1] *A Preliminary Dissertation illustrative of a new System of Pulmonary Pathology*, Bath, 1825.

[2] The mode of inhaling tar vapour will be described hereafter (see *Pix liquida*).

[3] *Edinburgh Medical and Surgical Journal*, vol. xix.

g. Recto-colic Membrane.—Sometimes, though less frequently than the stomach, the *rectum* is employed for the application of medicines. It has been asserted that the general susceptibility of the rectum is only one-fifth of that of the stomach, and that medicines take five times as long to operate by the former as by the latter: hence it has been said that both the dose, and the interval between the doses, should be five times as great as when applied to the stomach. But this assertion is far from being universally correct, though it may be so occasionally. Orfila asserts that those agents which operate by absorption, as opium and tobacco, are more active by the rectum than by the stomach; and he assigns as a reason the greater venous absorption of the rectum, and its less digestive power. But this statement is in direct opposition to the experience of almost every practitioner. Whenever I have had occasion to employ opium by way of enema, I always exhibit twice or three times the ordinary dose, without exciting any remarkable effects. Dr. Christison states that he has given two measured drachms of laudanum by injection, without producing more than usual somnolency; a quantity which, if Orfila's statement were correct, would probably prove fatal.

We apply medicines to the rectum, sometimes with the view of alleviating disease of this or of neighbouring organs (as of the uterus, bladder, prostate gland, &c.); at other times in order to irritate the rectum, and, on the principle of counter-irritation, to relieve distant parts (as the head); sometimes to produce alvine evacuations, or to dissolve hardened fæces; occasionally, also, when we are precluded from applying our remedies to the stomach, on account of their unpleasant taste and smell, the inability or indisposition of the patient to swallow, or the irritability of the stomach; and, lastly, in order to destroy the small thread-worm (*Ascaris vermicularis*).

When the substances applied to the rectum are solid, we name them *suppositories* (*suppositoria*, from *suppono*, to put under); but when of a fluid nature, they are termed *clysters*, *lavements*, or *enemata*.

Formerly *suppositories* were conical, or cylindrical, like a candle, and of variable size,—sometimes one or two inches long. They are now usually made globular, and of small size. They are employed to evacuate the bowels; to irritate the rectum, and thereby to relieve affections of distant organs; but more commonly to act as local agents in affections of the rectum, bladder, uterus, prostate gland, urethra, &c. A mixture of opium and soap is frequently employed with advantage, to prevent the pain of priapism during the night, in gonorrhœa.[1]

Clysters or *lavements* require to be considered under several points of view: *first*, in reference to the material of which they are made, and which must vary with the object for which these remedies are employed; *secondly*, with respect to the quantity of liquid used, and which will depend on the age of the patient. The average quantity for an adult is about twelve or sixteen ounces; and I believe that it is rarely proper to use more than this. I am sure that the practice of introducing several pints of fluid into the large intestines, with the view of exciting alvine evacuations, is bad. In the first place, it often provokes the contraction of the gut, by which the injection is immediately returned; and, secondly, repeated distension diminishes the susceptibility of the part, so that the ordinary accumulation of fæcal matter no longer acts as a sufficient stimulus. Mr. Salmon[1] has related a case of this kind, where the patient had nearly lost all power of relieving the bowels, except by enemata or purgatives, and had produced dilatation of the rectum, in consequence of having been in the habit of introducing into the intestine two quarts of gruel twice every day. A newly-born infant requires about one fluidounce; a child of one to five years, from three to four ounces; and a youth from ten to fifteen, from six to eight fluidounces. *Thirdly*, the impulse with which the fluid ought to be thrown up, deserves attention. If too much force be used, the sudden dilatation of the gut may bring on spasmodic action of its lower part, by which the clyster will be returned. *Fourthly*, the instruments by which the injection is effected require notice. The common pipe and bladder are too well known to require description. I am inclined to think that the most convenient, safe, and useful apparatus, is the elastic bottle and tube. Any quantity of liquid, however small, may be thrown up with the greatest ease, and without any danger of the impulse being too great. Its application is exceedingly convenient; a lusty person, by placing one foot on a stool or chair, may easily apply it without assistance; and its price is very moderate. Another form of enema apparatus is a narrow water-proof tube, holding about a pint of liquid, about four feet long, narrower at one end, which is furnished with a common injecting pipe, and about two and a half inches in diameter at the other. The fluid being placed in the tube, the pipe is introduced into the rectum, and the apparatus held in a perpendicular direction, by which the fluid is propelled into the gut by its own gravity.

---

[1] For some remarks on Suppositories, by Dr. Osborne, see *London Medical Gazette*, March 6, 1840.

Gaseous matters have been sometimes thrown into the rectum. Thus the injection of common air has been proposed in ileus[2]; tobacco-smoke has been employed in hernia; and carbonic acid gas in ulceration of the rectum.

2. URINO-GENITAL MEMBRANE. *a. Urethro-vesical membrane.*—Applications to the *urethra* are made only for local purposes; either in a solid form, as caustic or medicated bougies, or in that of a liquid, as an injection: the latter is easily applied by a common syringe.

Injections are sometimes thrown into the *bladder*, but always for local purposes. The operation is easily performed by attaching a catheter to an elastic bottle.

b. Vagino-uterine Membrane.—Medicines are applied to the *vagina* and *uterus*, to produce local effects only. Thus injections are made to relieve vaginal discharges, to excite the catamenia, &c. They are usually liquids, but in a case related to me by my friend Dr. Clutterbuck, carbonic acid gas was successfully employed to relieve an irritable uterus.

3. *Applications to the Serous Membranes.*

a. Tunica vaginalis.—Irritating injections, such as wine and water, solutions of metallic salts, &c. are thrown into the cavity of the serous membrane of the testicle in hydrocele, in order to excite inflammation and the subsequent adhesion of the sides of the sac.

b. Peritoneum.—Injections have also been made into the peritoneal sac in ascites, and in some cases with success.[1] The practice, however, is very dangerous, Mr. Cooper[2] has seen two fatal cases of it.

---

[1] *Practical Essay on Prolapsus of the Rectum*, p. 24, Lond. 1831.

[2] *Edinburgh Medical and Surgical Journal*, vol. xvi.

4. *Applications to Ulcers, Wounds, and Abscesses.*

These are employed principally to excite local effects, and sometimes, though rarely, to produce a constitutional affection. Thus it has been proposed to apply corrosive sublimate to wounds, with the view of causing salivation.

5. *Injections of Medicines into the Veins.*

(Chirurgia infusoria; Ars clysmatica nova; Infusion of medicines.)

The history of this operation is inseparably connected with that of *transfusion*. The first experiments on infusion are said to have been performed in Germany.[3] But the first scientific examination of the operation was made by Sir Christopher Wren.[4] His example was followed by Boyle, Clarke, Henshaw, Lower, and others.[5]

The partisans of this method of treatment assert, that when medicines are administered by the stomach, their properties are more or less altered by the digestive power of this viscus; and that by injecting medicines at once into the veins, we avoid this influence. The effects are of the same general nature as when medicines are applied to the skin or stomach: thus emetic tartar occasions vomiting, senna purges, opium stupifies, and so on. So that some of the supposed advantages of this operation have no real existence, while several objections to it exist: such as the danger of introducing air into the veins, or of throwing in too large a dose of the remedy (for a slight excess in some cases may prove fatal), or of the occurrence of phlebitis. These, then, are sufficient reasons for not resorting to this practice, except on very urgent occasions; for example, to excite speedy vomiting when the patient is unable to swallow. Köhler (mentioned by Dieffenbach, who notices also several other analogous cases) preserved the life of a soldier, in whose throat a piece of beef tendon was sticking, by throwing a solution of six grains of emetic tartar into a vein of the arm: vomiting was induced, and the meat expelled. Meckel injected two grains of this salt, dissolved in water, into the veins of a woman, to restore suspended animation from immersion in water. Lastly, cold water has been injected into the umbilical vein in cases of retained placenta.[6]

In some obstinate and dangerous diseases this operation is admissible as a last resource: for example, in cases of poisoning, in hydrophobia, in malignant cholera, &c. As plethora appears to diminish absorption, it has been proposed to throw tepid water into the venous system in cases of narcotic poisoning, and thus to cause artificial plethora, in order to prevent the occurrence of the symptoms of poisoning by stopping absorption. Vernière found that three grains of nux vomica produced no effect when applied to a wound in a dog, into whose veins water had been thrown; and he asserts, that by the early use of aqueous injections we may prevent the development of contagious diseases. Magendie proposed the injection of tepid water into the veins for the relief of hydrophobia. The operation was first performed at the Hôtel-Dieu, at Paris, in October, 1823: the convulsions were stopped, but the patient died in a day or two afterwards. This operation has been several times repeated, and with the same results. In June, 1832, I tried it on a patient (afflicted with this terrible disease) under the care of the late Mr. Bennett, of the Commercial Road: the patient was a boy about nine years of age; he was nearly insensible at the time I performed the operation. I threw in about one quart of tepid water without any obvious effect on the pulse: no convulsions were subsequently observed, but the patient died in a few hours. Saline solutions were injected into the veins in malignant cholera, and often with apparent advantage (see the article on *Sodii Chloridum*). Purgatives, narcotics, &c. have been thrown into the veins by different physiologists, and in most cases the effects observed were similar to, though more powerful than, those produced when these agents were administered by the stomach. To this statement, however, the oils are an exception; for when injected into the veins in large quantities they interrupt the circulation, and produce a kind of asphyxia.

---

[1] *Philosophical Transactions* for the year 1744.

[2] *Dictionary of Practical Surgery*, art. *Paracentesis.*

[3] See Paul Scheel's work, entitled "*Die Transfusion des Bluts und Einsprützung der Arzneyen in die Adern*," Kopenhagen, 1802: Zweiter Band, 1803.

[4] *Philosophical Transactions* for 1665, vol. i. p. 131.

[5] For further information on the history of this operation, consult Scheel's work, before quoted; also Dieffenbach's essay, "*Ueber die Transfusion des Bluts und die Infusion der Arznein*, 1833; or Marx's "*Die Lehre von den Giften*," 1827 and 1829.

[6] *British and Foreign Medical Review*, Jan. 1837 and Jan. 1838.

7. ON THE CLASSIFICATION OF MEDICINES.

In some works on medical botany, which contain figures of the plants employed in medicine, the authors have not followed any arrangement, in consequence, I presume, of the impossibility of procuring specimens in regular order. This is the case in the following works:—

W. Woodville, M.D.—Medical Botany, 3 vols. 4to. London, 1790.—A Supplement to the Medical Botany, 4to. London, 1794.—[In the second edition of this work, published in 1810, the subjects were arranged according to their natural orders.—The third edition, in 1832, by Dr. Hooker and Mr. Spratt, was, in fact, the second edition with a new title and an additional volume.]

J. Bigelow, M.D.—American Medical Botany, 3 vols. 8vo. Boston, 1817-18-20.

W. P. C. Barton, M.D.—Vegetable Materia Medica of the United States, 2 vols. 4to. Philadelphia, 1818.

J. Stephenson, M.D. and *J. M. Churchill*.—Medical Botany, 4 vols. 8vo. London, 1827-31.—2d ed. in 3 vols., by G. Burnett, 1834-36.

Flora Medica, 2 vols. 8vo. 1827.

The large number of substances employed in the treatment of diseases renders some arrangement of them almost absolutely necessary;—and I conceive any order of treating them to be better than none.

Arrangements or classifications of medicines, like those of plants,[1] may be divided into *empirical* and *rational* ones.

1. *Empirical Arrangements.*

These are independent of the nature of, and have no real relation or connection with, the substances to be arranged. An *alphabetical* order, since it is founded on names which are arbitrary and have no relation to the bodies they are intended to designate, is of this kind. Two advantages have been supposed to be gained by its employment: firstly, a ready reference to any particular substance; and, secondly, the avoidance of errors committed by writers who adopt other methods. But the first is more imaginary than real: for an index gives to any mode of classification every advantage derived from an alphabetical arrangement: and, as each substance is known by a variety of names, an index becomes as necessary to an alphabetical as to any other method. Like other classifications, this has its disadvantages, the most important of which are, that it brings together substances of the most incongruous natures, and separates those which agree in most of their properties; and from its want of order, it distracts the attention of the student, and is, therefore, totally unfitted for an elementary work.

---

[1] *Théorie Elémentaire di la Botanique*, par A. P. De Candolle, Paris, 1819.

The following are some of the more important works in which medicines are described in an alphabetical order:—

M. de la Beyrie and *M. Goulin*—Dictionnaire raisonné-universel de Matière Médicale, t. viii. Paris, 1773.
J. Rutty—Mat. Medica antiqua et nova, repurgata et illustrata, 4to. Rotterodami, 1775.
W. Lewis—An Experimental History of the Materia Medica, 4to. 1761.—4th edition, by Dr. Aikin, 2 vols. 8vo. 1791.
Andrew Duncan, jun. M.D.—The Edinburgh New Dispensatory, 11th edit. Edinburgh, 1826.—Supplement to the above. 1829.
J. R. Coxe, M.D.—The American Dispensatory. Philadelphia, 1826.
J. Thacker, M.D.—The American New Dispensatory. Boston, 1810.—2d edition. 1813.
A. T. Thomson, M.D.—The London Dispensatory. London, 1811.—10th edition. 1844.
J. A. Paris, M.D.—Pharmacologia, 3d edition, 1820.—8th edition, 1833.—App. 1838.
W. Ainslie, M.D.—Materia Indica, 2 vols. London, 1826.
W. T. Brande—A Manual of Pharmacy. London, 1825.—3d edition. 1853.
A. Chevallier, *A. Richard*, and *J. A. Guillemin.*—Dictionnaire des Drogues simples et composées, tom. v. Paris, 1827-9.
F. P. Dulk—Die Preussische Pharmakopöe, übersetz und erläutert, 2te Aufl. 2 Th. 8vo. Leipsig, 1830.
L. Martinet—Manuel de Thérapeutique et de Matière Médicale. Paris, 1828.
F. S. Ratier—Traité élémentaire de Matiére Médicale, tom. ii. Paris, 1829.
F. V. Mérat et *A. J. De Lens*—Dictionnaire universel de Matièrė Médicale et de Thérapeutique Générale, tom. vi. 1829-34.—Tom. vii. Supplement. 1846.
L. W. Sachs and *F. P. Dulk*—Handwörterbuch der praktischen Arzneimittellehre, 19 Lief. A—St. Königsberg, 1830-37.
G. B. Wood, M.D. and *F. Bache*, M.D.—The Dispensatory of the United States of America. 1833.—3d edition. 1836.—5th edition. 1843.
Bachmann, *W. L.*—Handwörterbuch der praktischen Apothekerkunst, 2 Bde. Nürnberg, 1837.
A. Ure, M.D.—A Practical Compendium of the Materia Medica, with numerous Formulæ for the Treatment of Diseases of Infancy and Childhood. London, 1838.
E. Winkler—Vollständiges Real Lexicon der medicinisch-pharmaceutischen Naturgeschichte und Rohwaarenkunde, 8vo. Leipzig, 1838-42.
W. T. Brande—Dictionary of Materia Medica and Practical Pharmacy. 8vo. Lond. 1839.
R. Christison, M.D.—A Dispensatory, or Commentary on the Pharmacopœias of Great Britain, 8vo. Edinburgh, 1842.
G. F. Most—Encyklopädisches Handwörterbuch der praktischen Arzneimittellehre, 8vo. Rostoch and Schwerin, 1841.
R. Paulus—Taschenwörterbuch der Materia Medica. Unter geigneter Berücksichtigung auch der in neuer Zeit empfohlenen Arzneimittel. Stuttg. 1841.
Martiny Julius und *Dr. Ed.*—Encyklopädie der medicinisch-pharmaceutischen Naturalien und Rohwaarenkunde, 1er Bd. A—F, 8vo. Quedlinburg und Leipzig, 1843.

2. *Rational Arrangements.*

These have an actual relation with the bodies for which they are used, and are the classifications, properly so called. They are founded on the properties of the substances treated of; consequently are as numerous as there are classes of properties. Thus medicines may be arranged according to their

α. Sensible properties (colour, taste, and smell).
β. Natural-historical properties (external form and structure).
γ. Chemical properties.
δ. Physiological effects.
ε. Therapeutical properties.

a. Classifications founded on the Sensible Qualities.

Classifications founded on the colour, taste, and odour of plants, are necessarily very imperfect, owing to the impossibility of defining sensations. Moreover, their use is very limited, in consequence of these properties having no necessary relation to the medicinal powers (see p. 84). In the best executed arrangements of this kind, the denominations of many of the classes, or orders, are objectionable,—dissimilar bodies are brought together, and similar ones separated.

The following writers have offered the best examples of this mode of classification:—

Jos. Osborne, M.D.—On the Indications afforded by the Sensible Qualities of Plants with respect to their Medicinal Properties. Contained in the Transactions of the Association of Fellows and Licentiates of the King's and Queen's College of Physicians, vol. v. 1828.

A. F. A. Greeves.—An Essay on the Varieties and Distinctions of Tastes and Smells, and on the Arrangement of the Materia Medica. [Published by *Dr. Duncan*, in his Supplement to the Edinburgh New Dispensatory. 1829.]

MR. GREEVES' CLASSIFICATION.

CLASSES.	FAMILIES.	ORDERS.	EXAMPLES.
I. INODOROUS AND INSIPID	1. *Liquid*	1.	Water.
	2. *Soft*	1. Pulverescent	Creta.
		2. Unctuous	White Wax.
	3. *Hard*	1. Tough	Iron.
		2. Brittle	Antimony.
II. INODOROUS AND SAPID	1. *Sweets*	1. Saccharine	Sugar.
		2. Amylaceous	Starch.
		3. Mucous or Unctuous	Gum.
		4. Faint	Castor Oil.
		5. Frugous	Tamarinds.
	2. *Bitters*	1. Mawkish	Elaterium.
		2. Astringent	Catechu and Alum.
		3. Pure bitter	Quassia.
		4. Austere	Galls.
		5. Styptic	Sulphate of Copper.
		6. Acrid	Colchicum.
		7. Salino-amare	Nitre.
	3. *Alkalines*	1.	Potash.
	4. *Acids*	1. Pure acid	Citric Acid.
		2. Saccharo-acid	Orange Juice.
	5. *Salines*	1. Pure Salt	Common Salt.
III. ODOROUS AND INSIPID	1. *Fragrant*	1. Sweet	Yellow Wax.
		2. Aromatic	Saunder's Wood.
IV. ODOROUS AND SAPID	1. *Sweets*	1. Saccharine	Honey.
		2. Faint	Senna.
		3. Sweet-spicy	Caraway.
	2. *Bitters*	1. Mawkish	Jalap.
		2. Subastringent	Rhubarb.
		3. Bitter-spicy	Cascarilla.
		4. Sharp-bitter	Aloes.
		5. Austere	Cinchona.
		9. Subacrid	Ipecacuanha and Musk.
		7. Acrid	Copaiba.
	3. *Acidous*	1.	Acetum.
	4. *Camphreous*	1. Camphreous aromatics	Cloves.
		2. Savoury	Pepper.
		3. Terebinthinate	Turpentine.
		4. Camphreous	Camphor.
	5. *Spirituous*	1. Vinous	Wine.
		2.	Alcohol.

β. Classifications founded on the Natural-Historical Properties.

By natural-historical properties, I mean those made use of in natural history. They are principally external form and structure. In living beings we find that peculiar structure denominated *organised*. The structure called *crystalline* is peculiar to mineral and other inorganised bodies.

αα. Vegetables and Animals.

Both the *vegetable* and *animal* materia medica are arranged according to the natural system in the following works :—

J. J. Virey—Histoire Naturelle des Medicamens. Paris, 1820.
A. L. A. Fée—Cours d'Histoire Naturelle pharmaceutique, t. ii. Paris, 1828.
A. Richard—Elémens d'Histoire Naturelle Médicale, t. ii. Paris, 1831.
J. Johnstone, M.D.—A Therapeutic Arrangement and Syllabus of Materia Medica, 12mo. London, 1835.
E. Soubeiran—Nouveau Traité de Pharmacie théorique et pratique, t. ii. Paris, 1836. 2nde édition, 1840.—3e éd. 1847.
S. Dieu—Traité de Matière Médicale et de Thérapeutique, précédé de considérations générales sur la Zoologie, et suivi de l'Histoire des Eaux Naturelles, t. i. and ii. 8vo. Paris, 1847.
Dr. Ed. Ballard and *Dr. A. B. Garrod*—Elements of Materia Medica and Therapeutics, 8vo. London, 1845.
Ph. L. Geiger—Handbuch der Pharmacie.—Pharmaceutische Botanik, 2te Aufl. neu bearbeitet von Dr. T. F. L. Nees von Esenbeck.—Pharmaceutische Zoologie, 2te Aufl. neu bearbeitet von Dr. Cl. Marquart, 8vo. Heidelberg. 1839.
Dr. Cl. Marquart—Lehrbuch der praktischen und theoretischen Pharmacie, 2 vols. 8vo. Mainz. 1844.
Dr. J. F. Royle—A Manual of Materia Medica and Therapeutics. 12mo. Lond. 1853.

As in the subsequent part of this work the vegetable and animal substances used in medicines will be arranged in natural-historical order, it will be unnecessary here to offer any examples illustrative of this classification. I have preferred this mode of arrangement principally on account of the great difficulties attending any other method, especially that founded on the physiological effects of medicines.

ββ. Vegetables only.

In the following works the *vegetable* substances employed in medicine are arranged according to their natural-historical properties :—

J. A. Murray—Apparatus Medicaminum tam simplicium quam præparatorum et compositorum, vol. v. Göttingæ, 1776-19.—Post mortem auctor. edid. *L. C. Allnof*, vol. vi. Göttingæ, 1792.
A. P. De Candolle—Essai sur les Propriétés Médicales des Plantes, comparées avec leurs Formes Extérieurs et leur Classification Naturelle, 1804.—2d édition. Paris, 1816.
A. Richard—Botanique Médicale. Paris, 1823.
P. J. Smyttère—Phytologie-pharmaceutique et Médicale. Paris, 1829.
J. H. Dierbach—Abhandlung über die Arzneikräfte der Pflanzen verglichen mit ihrer Structur und ihren chemischen Bestandtheilen. Lemgo, 1831.
T. F. L. Nees von Esenbeck und *C. N. Ebermair*—Handbuch der medicinisch-pharmaceutischen Botanik, 3 Th. Düsseldorf, 1830-32.
V. Fr. Kosteletzky—Allgemeine medizinisch-pharmazeutische Flora, 6 Bde. Prague, 1831-36.
G. W. Bischoff—Medicinisch-pharmaceutische Botanik. Erl. 1843.
S. Endlicher—Die Medicinal Planzen der österreichischen Pharmakopöe. Ein Handbuch für Aerzte and Apotheker, 8vo. Wien, 1842.
C. F. P. von Martius—Systema Materiæ Medicæ Vegetabilis Brasiliensis Lipsiæ et Vindeb 8vo. 1843.

γγ. Animals only.

The *animal* substances used in medicine are arranged in natural-historical order in the following works :—

J. F. Brandt und *J. T. C. Ratzeburg*—Medizinische Zoologie oder, getreue Darstellung und Beschreibung der Thire, die in der Arzneimittellehre in Betracht kommen in systematischer Folge herausgegeben, 2 Bde. Berlin, 1827-33.
John Stephenson, M.D.—Medical Zoology and Mineralogy. London, 1832.
Dr. T. W. C. Martius—Lehrbuch der pharmaceutischen Zoologie. Stuttgart, 1838.
Dr. Ed. Martiny—Naturgeschichte der für die Heilkunde wichtigen Thiere mit besonderer Rücksicht auf Pharmacologie, Pathologie und Toxicologie, 8vo. Darmstadt, 1847.

δδ. Minerals only.

I am unacquainted with any pharmaceutical work in which the inorganised substances of the materia medica are arranged in natural-historical order. Most writers who have followed the natural system in their descriptions of vegetable and animal medicines, have adopted a chemical classification for the inorganised medicinal substances—a mode of proceeding which I shall follow in this work. In the following works on minerals a natural-historical classification is observed.

F. Mohs—Treatise on Mineralogy, translated by W. Haidinger, 3 vols. Edinb. 1825.
Robert Allan—Manual of Mineralogy. Edinburgh, 1834.
J. D. Dana—A System of Mineralogy, comprising the most recent Discoveries, 2d edition. New York, 1844.

CRYSTALLOGRAPHICAL CLASSIFICATION OF PHARMACEUTICAL SUBSTANCES.

Modern crystallographers[1] arrange crystalline forms in six groups, called *systems*, each of which comprehends all those forms which agree in the number, length, and direction of the axes. These six systems may be conveniently arranged in two classes, as follows :—

CLASSES.			SYSTEMS.
I. EQUIAXED OR MONOMETRIC			1. The Regular or Cubic.
II. UNEQUIAXED	a. Dimetric	Quadrate	2. The Square Prismatic.
		Hexagonal	3. The Rhombohedric.
	β. Trimetric	Erect	4. The Right Prismatic.
		Oblique	5. The Oblique Prismatic.
		Doubly-oblique	6. The Doubly-oblique Prismatic.

---

[1] For further details, the reader is referred to the following works :—

1. *Elemente der Krystallographie, nebst einer tabellarischen Uebersicht der Mineralien nach den Krystallformen*, von Gustav Rose, Zweite Auflage. Berlin, 1838. [A French translation of the first edition was published in Paris, 1834.)
2. *A Treatise on Crystallography*, by W. H. Miller, M.A. F.R.S. &c. Cambridge, 1839.
3. *A System of Crystallography, with its application to Mineralogy*, by John Joseph Griffin. Glasgow, 1841.
4. *Encyclopædia Metropolitana*, art. *Crystallography*, by Mr. Brooke.
5. *Tabelle über die natürlichen Abtheilungen der verschiedenen Crystallisationssysteme*, nach Prof. C. S. Weiss, für Vorlesungen zusammengestellt und durch Figuren erläutert von Dr. J. T. C. Ratzeburg.
6. *Le Règne Minéral ramené aux Méthodes de l'Histoire Naturelle*, par L. A. Necker, tome 2. Paris, 1835.
7. *Elémens de Crystallographie*, par M. J. Müller, traduits de l'allemand et annotés par J. Nicklès. Paris, 1847.
8. *Précis de Crystallographie, suivi d'une Méthode simple d'Analyse au Chalumeau, d'après des Leçons particulières* de M. Laurent. Paris, 1847.

CLASS I.—*Equiaxed or Monometric*[1] *Crystals.*

(Isometric[2] Crystals.)

CHARACTERS.—*Geometric;* three rectangular and equal axes. *Optical:* refraction single *Thermotic:* expansion by heat equal in all directions.

⁂ As the refraction of this class is single, the crystals present no rings when tested by polarised light.

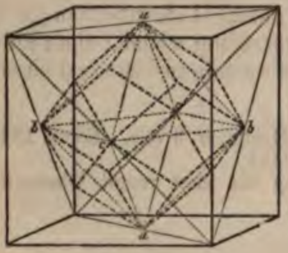
System 1.—The Regular System.

(Tessular system, *Mohs;* Octohedral System, *Miller.* Tetrahedric, Cubic, Equal-membered, or Equal-axed System.

CHARACTERS.—Those of the class.

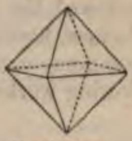
Forms.—To this system belong the ***cube***, the ***regular octohedron***, the ***rhombic dodecahedron***, and the ***regular tetrahedron***.

FIG. 17.



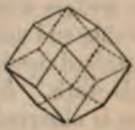
Four forms of the cubic system ; viz. cube, regular tetrahedron, rhombic, dodecahedron, *and* regular octahedron.
a a, b b, c c, The three rectangular equal axes.

FIG. 18.



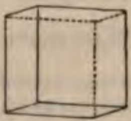
Octohedron.

FIG. 19.



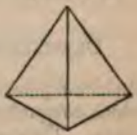
Dodecahedron.

FIG. 20.



Cube.

FIG. 21.



Regular tetrahedron.

EXAMPLES.—The following substances belong to this system :—

Diamond.
Phosphorus.
Potassium.
Sodium.
Bismuth.
Lead.
Cadmium.
Titanium.
Iron.
Copper.
Mercury.
Silver.
Gold.
Platinum.
Arsenious Acid.
Magnetic Oxide of Iron.
Chloride of Ammonium (*Sal Ammoniac*).
Chloride of Potassium.
Chloride of Sodium.
Chloride of Silver.
Iodide of Potassium.
Iodide of Sodium.
Bromide of Potassium.
Bromide of Sodium.
Bromide of Silver.
Fluoride of Calcium.
Sulphuret of Lead (*Galena*).
Sulphuret of Silver.
Bi-sulphuret of Iron (*Mundic*).
Sulphuret of Zinc (*Blende*).
Sulphuret of Tin (*Tin Pyrites*).
Nitrate of Lead.
Nitrate of Baryta.
Nitrate of Strontian.
Alum.

CLASS II.—*Unequiaxed Crystals.*

CHARACTERS.—*Geometric:* not three rectangular and equal axes. *Optical:* refraction double *Thermotic:* expansion not equal in all directions.

⁂ As the refraction of this class is double, the crystals present, in certain directions, rings when tested by polarized light.

---

[1] Monometric, from *μόνος, one,* and *μετρον, a measure*—axes of one kind or measure.

[2] Isometric, from *ἴσος, equal,* and *μετρον, a measure*—axes equal.

a. Dimetric Crystals.

CHARACTERS.—*Geometric:* axes of two kinds; at least, two equal axes. *Optical:* refraction double in all directions except one (one axis of double refraction). *Thermotic:* expansion equal in two directions at least.

⁂ As the crystals of this sub-class have only one axis of double refraction, they present a single system of rings, intersected by a cross, when placed in the polariscope. (See figs. 22 and 23.)

FIG. 22.

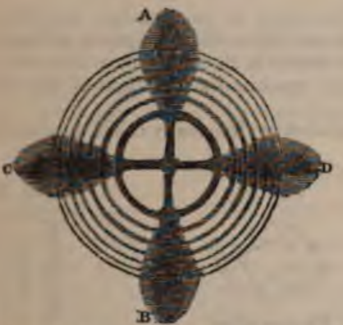
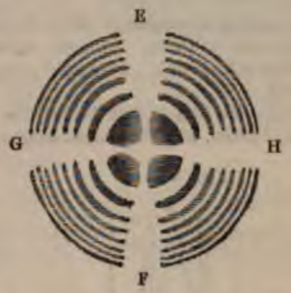


FIG. 23.



Single system of rings seen by looking through a slice of calcareous spar (cut perpendicular to the axis of the crystal) placed in the polariscope.

When the polariser and analyser are at right angles to each other, the cross is a black one (fig. 22, A, B, C, D); but when the positions of the polariser and analyser coincide, the cross is a white one (fig. 23, E, F, G, H).

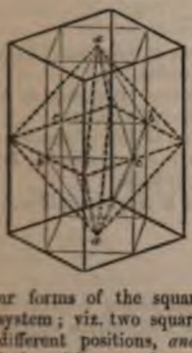
System 2.—Square Prismatic System.

(Pyramidal System, *Mohs* and *Miller*. The 2- and 1-axed System, *Rose*. The 4-membered System.)

CHARACTERS.—*Geometric:* axes three, rectangular; only two equal. *Optical:* refraction double in all directions except one (one axis of double refraction). *Thermotic:* expansion equal in two rectangular directions only.

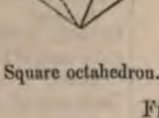
FORMS.—To this system belong the *octahedron with a square base*, and the *right square prism.*

FIG. 24.



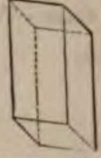
Four forms of the square prismatic system; viz. two square prisms in different positions, *and* two octahedra with square bases.
a a, Principal axis; *b b*, *c c*, secondary axes.

FIG. 25.



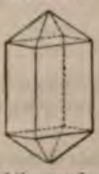
Square octahedron.

FIG. 26.



Square prism.

FIG. 27.



Combination of the octahedron and prism.

---

[1] Dimetric, from δίς, *twice*, and μετρον, *a measure*—axes of two kinds.

EXAMPLES.—The following substances belong to this system :—

Peroxide of Tin (*Tin-stone*).
Chloride of Mercury (*Calomel*).
Sulphuret of Copper and Iron (*Copper Pyrites*).
Bicyanide of Mercury.
Ferrocyanide of Potassium.
Acid Triphosphate of Potash and Water.
Acid Triphosphate of Oxide of Ammonium and Water.
Acid Triarseniate of Potash and Water.
Acid Triarseniate of Oxide of Ammonium and Water.

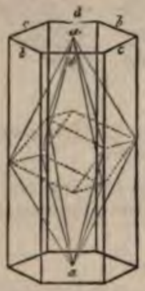
System 3.—Rhombohedric System.

(Rhombohedral System, *Miller*. The 3- and 1-axed System, *Rose*.)

CHARACTERS.—*Geometric:* axes four; three equal to one another, and placed in one plane, crossing at angles of 60°; the fourth axis differs from the others in length, and is perpendicular to them. *Optical:* refraction double in all directions except one (one axis of double refraction). *Thermotic:* expansion equal in the directions of the three equal axes only.

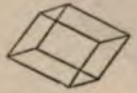
FORMS.—To this system belong the *rhombohedron* (frequently called a rhomboid), the *hexagonal prism*, and the *scalenohedron*.

FIG. 28.



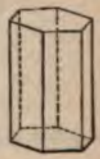
Three forms of the rhombohedric system; viz. the hexagonal prism, the scalene dodecahedron, and the rhombohedron.
a a, The principal axis; *b b*, *c c*, *d d*, secondary axes.

FIG. 29.



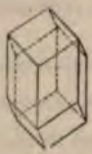
Rhombohedron.

FIG. 30.



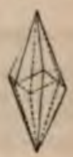
Hexagonal prism.

FIG. 31.



Combination of the rhombohedron with the hexagonal prism.

FIG. 32.



Scalenohedron.

EXAMPLES.—The following substances belong to this system :—

Antimony.
Arsenic.
Zinc?
Tin?
Plumbago.
Ice.
Oxide of Zinc.
Sesquioxide of Iron (*Specular Iron*).
Sulphuret of Mercury (*Cinnabar*).
Sulphuret of Iron (*Magnetic Pyrites*).
Chloride of Calcium.
Carbonate of Lime (*Calcareous Spar*).
Carbonate of Magnesia (*Magnesite*).
Carbonate of Lime and Magnesia (*Dolomite*).
Carbonate of Protoxide of Manganese (*Diallogite*).
Carbonate of Zinc (*Calamine*).
Carbonate of Iron (*Spathic Iron*).
Nitrate of Soda.
Hydrate of Magnesia (*Brucite*).

β. Trimetric[1] Crystals.

CHARACTERS.—*Geometric:* axes three, unequal. *Optical:* refraction double in all directions except two (two axes of double refraction). *Thermotic:* expansion unequal in three directions.

⁂ As the crystals of this subclass have two axes of double refraction, a double system of rings, intersected by bands, is seen when they are placed in the polariscope (see figs. 33 and 34).

---

[1] Trimetric, from τρίς, *thrice*, and μετρον, *a measure*—axes of three kinds.

FIG. 33.

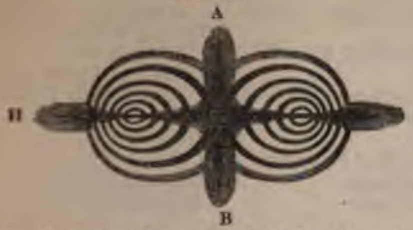
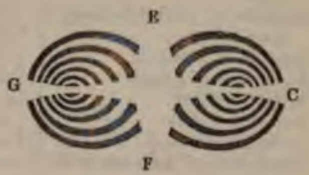


FIG. 34.



Double system of rings seen by looking through a slice of nitre (cut perpendicularly to the prismatic axis of the crystal), placed in the polariscope,

When the polariser and analyser are at right angles to each other, the cross is a black one (fig. 33, A, B, C, D); but when the position of the polariser and analyser coincides, the cross is a white one (fig. 34, E, F, G, H).

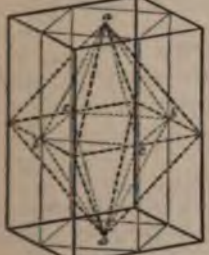
System 4.—Right Prismatic System.

(Prismatic System, *Miller*. The 1- and 1-axed System, *Rose*. The 2- and 2-membered System.)

CHARACTERS.—*Geometric:* axes three, rectangular, unequal. *Optical:* refraction double in all directions except two (two axes of double refraction). *Thermotic:* expansion relatively unequal in the directions of all the axes.

FORMS.—To this system belong the *octahedron with a rectangular base*, the *right rectangular prism*, the *octahedron with a rhombic base*, and the *right rhombic prism*.

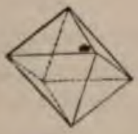
FIG. 35.



Four forms of the right prismatic system; viz. right rectangular prism, right rhombic prism, rectangular octahedron, and rhombic octahedron.

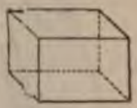
a a, Principal or prismatic axis; *b b*, *c c*, secondary axes.

FIG. 36.



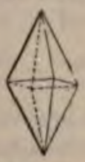
Octahedron with a rectangular base.

FIG. 37.



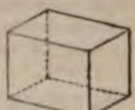
Right rectangular prism.

FIG. 38.



Octahedron with a rhombic base.

FIG. 39.



Right rhombic prism.

EXAMPLES.—The following substances belong to this system:—

Iodine.
Sulphur (native).
Selenium?
Binoxide of Manganese (*Pyrolusite*).
Teroxide of Antimony (*White Antimony*.)
Chloride of Barium.
Bichloride of Mercury (*Corrosive Sublimate*).
Tersulphuret of Antimony (*Gray Antimony*).
Tersulphuret of Arsenic (*Orpiment*).
Bisulphuret of Iron (*Radiated Pyrites*).
Arsenical Pyrites (*Mispickel*).
Sulphuret of Bismuth.
Bisulphate of Potash.
Sulphate of Potash.[1]
Sulphate of Magnesia.
Sulphate of Zinc.
Sulphate of Baryta (*Heavy Spar*).

[*Continued.*

---

[1] The common bipyramidal crystals of sulphate of potash are composite crystals made up of several crystals belonging to the right prismatic system, agglutinated so as to form bipyramidal dodecahedra, simulating the crystals of the rhombohedric system (Brewster).

Sulphate of Strontian (*Celestine*).
Sulphate of Lead (*Prismatic Lead Spar*).
Sulphate of Ammonia.
Perchlorate of Potash.
Nitrate of Silver.
Nitrate of Potash.
Carbonate of Potash.
Bicarbonate of Ammonia with $2\frac{1}{2}$ HO.
Bicarbonate of Potash.
Carbonate of Lime (*Arragonite*).
Carbonate of Lead (*White-Lead Ore*).
Carbonate of Baryta (*Witherite*).
Carbonate of Strontian (*Strontianite*).
Ferridcyanide of Potassium.
Acetate of Baryta.
Acetate of Lead.
Bitartrate of Potash (*Cream of Tartar*).
Tartrate of Potash and Soda (*Rochelle Salt*).
Tartrate of Potash and Antimony (*Emetic Tartar*).
Citric Acid.
Morphia.
Codeia.
Narcotina.
Asparagine.

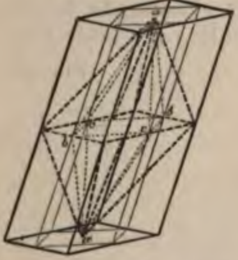
System 5.—Oblique Prismatic System.

(The 2- and 1-membered System, *Rose*.)

CHARACTERS.—*Geometric*: axes three, all unequal; two of them cut one another obliquely, and are perpendicular to the third. *Optical:* refraction double in all directions except two (two axes of double refraction). *Thermotic*: expansion in the direction of the axes relatively unequal.

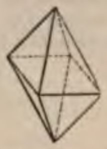
FORMS.—To this system belong the ***oblique octahedron with a rectangular base***, the ***oblique rectangular prism***, the ***oblique octahedron with a rhombic base***, and the ***oblique rhombic prism***. Mr. Brooke[1] refers the ***right oblique-angled prism*** to this group.

FIG. 40.



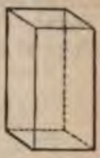
Four forms of the oblique prismatic system; viz. oblique rectangular prism, oblique rhombic prism, oblique rectangular octahedron, and oblique rhombic octahedron.
a a, Principal axis; *b b*, *c c*, secondary axes.

FIG. 41.



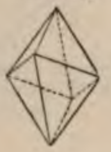
Oblique octohedron with a rectangular base.

FIG. 42.



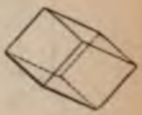
Oblique rectangular prism.

FIG. 43.



Oblique octahedron with a rhombic base.

FIG. 44.



Oblique rhombic prism.

The following substances belong to this system:—

Sulphur (by slow cooling).
Bisulphuret of Arsenic (*Realgar*).
Oxysulphuret of Antimony (*Red Antimony*).
Sulphate of Soda.
Sulphate of Iron.
Sulphate of Lime (*Selenite*).
Chlorate of Potash.
Triphosphate of Soda and Basic Water (*Rhombic Phosphate*).
Borax (*Tincal*).
Carbonate of Soda.
Sesquicarbonate of Soda (*Trona, Urao*).
Acetate of Soda.
Acetate of Copper.
Acetate of Zinc.
Binacetate of Copper.
Binoxalate of Potash.
Cinnamic Acid.
Succinic Acid.
Tartaric Acid.
Oxalic Acid.
Sugar.
Crystals from Oil of Cubebs.

System 6.—Doubly-oblique Prismatic System.

(The 1- and 1-membered System, *Rose*.)

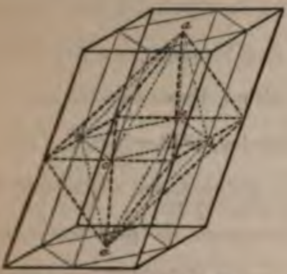
CHARACTERS.—*Geometric*: axes three, all unequal, and oblique-angular to one another. *Optical*: refraction double in all directions except two (two axes of double refraction). *Thermotic*: expansion in the direction of the axes relatively unequal.

---

[1] *Encyclopædia Metropolitana*, art. *Crystallography*.

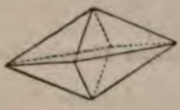
FORMS.—To this system belong the *doubly-oblique octahedron* and the *doubly oblique prism*.

FIG. 45.



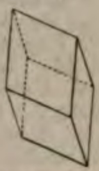
Four forms of the doubly-oblique system; viz. two doubly-oblique prisms, and two doubly-oblique octahedra.
a a, Principal axis; *b b*, *c c*, secondary axes.

FIG. 46.



Doubly-oblique octahedron.

FIG. 47.



Doubly-oblique prism.

EXAMPLES.—The following substances belong to this system:—

Boracic Acid.
Paratartaric Acid (*Racemic Acid*).
Gallic Acid.
Sulphate of Protoxide of Manganese with 5 HO.
Sulphate of Copper (*Blue Vitriol*).
Sulphate of Cinchonia.
Nitrate of Bismuth.
Quadroxalate of Potash.
Succinate of Ammonia.

Isomorphism.—I have already (p. 84) had occasion to allude to the relation which Dr. Blake believes to exist between isomorphism and the physiological effects of crystalline substances.

εε. Artificial Method of Linnæus.

This appears to me the best place for noticing those pharmacological works in which the Linnæan artificial method of arranging plants is followed.

Car. A. Linné—Materia Medica, ed. 4a, curante J. C. D. Schrebero. Lipsiæ et Erlangæ, 1782.
P. J. Bergius—Materia Medica e Regno vegetabili, 2 tom. ed. 2nda. Stockholmiæ, 1782.
P. L. Geiger—Handbuch der Pharmacie, 2 Bde. Heidelberg, 1829. [The second edition is arranged in natural-historical order.]
A. A. da Silveira Pinto—Pharmacographia do Codigo Pharmaceutico Lusitano. Coimbra, 1836.

ζζ. Methods founded on the Parts of Organized Beings employed.

In some works, the vegetable and animal substances employed in medicine are classified according to the parts used; as barks, roots, seeds, secretions, &c.

R. A. Vogel—Historia Materiæ Medicæ. Lugd. Batav. et Lipsiæ, 1758.
C. Alston, M.D.—Lectures on the Materia Medica, 2 vols. London, 1770.
J. C. Ebermaier, M.D.—Taschenbuch der Pharmacie. Leipzig, 1809.
N. J. B. G. Guibourt—Histoire abrégée des Drogues simples, 2de éd. Paris, 1826.—3me éd. 1836.
Dr. F. Goebel and *Dr. G. Kunze*—Pharmaceutische Waarenkunde. Eisenach, 1827-29.
Dr. T. W. C. Martius Grundriss der Pharmakognosie des Pflanzenreiches. Erlangen, 1832.

γ. Classifications founded on the Chemical Constituents.

The difficulties attending the analysis of organised substances present a great obstacle to the formation of a chemical classification. Most of the writers who have attempted an arrangement of this kind are Germans.

Donald Monro—A Treatise on Medical and Pharmaceutical Chemistry, and the Materia Medica, 3 vols. London, 1788.

F. J. Voltelen—Pharmacologia universa, 8vo. Lugd. Bat. 1797-1802.

C. H. Pfaff—System der Materia Medica nach chemischen Principien mit Rücksicht auf. d. sinnl. Merkmale und d. Heilverhältnisse der Arzneimittel, 7 Bde. Leipzig, 1808-24.

F. A. C. Gren—Handbuch der Pharmacologie, 3te Aufl. herausgegeben von *Berhardi* und *Buchholz*, 2 Bde. Halle u. Berlin, 1813.

F. G. Voigtels—Vollständ. System der Arzneymittellehre, herausgegeben von *Kuhn*, 4 Bde. Leipzig, 1816-17.

C. W. Hufeland—Conspectus Materiæ Medicæ. Berolini, 1816.—Edit. 2. 1820.—Edit. 3. 1828.

G. W. Schwartze—Pharmacologische Tabellen, oder systematische Arzneimittellehre in tabellarischer Form. fol. Leipzig, 1819-25. 2 Aufl. 1833.

G. A. Richter—Ausführliche Arzneimittellehre. Handbuch für praktische Aerzte. 5 Bde. u. l.—Suppl. 1826-32.

L. A. Kraus—Wissenchaftliche Uebersicht der gesammten Heilmittellehre. Götting. 1831.

J. F. Sobernheim—Handbuch der praktischen Arzneimittellehre, 4to. Berlin, 1841.—5te Ausg. Berlin, 1844.

As an example of a chemical classification, I shall select that of Schwartze, and must refer the reader to the late Dr. Duncan's (jun.) *Edinburgh Dispensatory*, 11th edit. p. 172, for Plaff's chemical classification of the vegetable materia medica.

SCHWARTZE'S CLASSIFICATION.

Div.
1. Aqua communis.
2. Gummosa, mucilaginosa.
3. Farinosa, amylacea.
4. Gelatinosa.
5. Albuminosa.

Div.
6. Saccharina.
7. Pinguia-oleosa.
8. Extractiva amara.
9. Adstringentia seu Tannica.
10. Ætherea-oleosa.

Div.
11. Resinosa.
12. Narcotica.
13. Spirituosa.
14. Acida.
15. Alcalina.
16. Salina.

Div.
17. Metallica.
18. Corpora simplicia, solida, non metallica.
19. Kalia sulphurata.
20. Sapones.

It will be observed that the author has not always founded his divisions on the chemical properties of medicines; since some of them refer partly or wholly to the effects produced by these agents on the body. The nomenclature is not always perfect: thus, his seventeenth class is called "Metallica," as if it alone contained metallic substances; whereas divisions fifteen and sixteen also contain them. Again, some of the divisions, for example "Resinosa," contain substances whose effects are most dissimilar, while substances of analogous operation are placed in separate divisions.

αα Inorganic Substances.

The mineral and other inorganic substances of the Materica Medica are arranged chemically in the following works:—

J F. Gmelin—Apparatus Medicaminum. P. II. Regnum Minerale complectens, 2 vols. 8vo. Goettingæ, 1795-6.

J. Stephenson, M.D. Medical Zoology and Mineralogy. Lond. 1832.

Geiger's Handbuch der Pharmacie—Pharmaceutische Mineralogie, von. *P. L. Geiger.* 2te Aufl. neu bearbeitet von Dr. *Clamor Marquart*. 1838.

Cl. Marquart—Lehrbuch der praktischen und theoretischen Pharmacie. Pharmaceutische Mineralogie (in the first volume). Mainz, 1844.

M. A. Richard—Précis Elémentaire de Minéralogie, contenant des notions générales sur la Minéralogie, et la description des toutes les espéces employeés dans les Arts et particulièrement la Médecine. Paris, 1835.

Dr. E. Ballard and *Dr. A. B. Garrod*—Elements of Materia Medica and Therapeutics. London, 1845.

Dr. J. F. Royle.—A Manual of Materia Medica and Therapeutics. London, 1847.

The inorganic substances of the present work are arranged on chemical principles.

c. Classifications founded on the Physiological Effects of Medicines.

As the ultimate object of all our inquiries into the Materia Medica is to obtain a knowledge of the mode of operation of medicinal substances, it follows, that the most desirable and useful, because the most practical, classification of these agents, would be that founded on the similarity of their effects. But so many difficulties exist in the way of producing such an arrangement—so much remains yet to be determined with respect to the nature of the modifications impressed on the organised tissues by the influence of medicines—that it must be evident to every one who attentively studies the subject, that, in the present state of our knowledge, no such classification can be satisfactorily effected.

Physiological classifications are variously formed. Those that I am acquainted with may be reduced to six groups or classes. Thus, they may be arranged:—

1. According to the general quality of the effects.
2. According to Brunonian principles.
3. According to the doctrine of contra-stimulus.
4. According to the doctrine of Broussais.
5. According to chemico-physiological principles.
6. According to the part affected.

1. According to the General Quality of the Effects.

These arrangements are founded on the *nature*, *quality*, or *general character* of the effects; as in the following works:—

W. Cullen, M.D.—Treatise of the Materia Medica. Edinburgh, 1789.
R. Pearson, M.D.—A Practical Synopsis of the Materia Alimentaria and Materia Medica. London, 1808.
C. I. A. Schwilgué—Traité de Matière Médicale, 2 tom. Paris, 1818.
J. Arnemann—Chirurgische Arzneimittellehre, 6te Aufl. von *A. Kraus*. 1818.
J. Arnemann—Praktische Arzneimittellehre, 6te Aufl. von *L. A. Kraus*. 1819.
T. Young, M.D.—An Introduction to Medical Literature, art. Pharmacology, 2d edition. 1823.
J. B. G. Barbier—Traité Elémentaire de Matière Médicale, 2nde édit. 3 tom. Paris, 1824.—4e édit. 1837.
N. Chapman, M.D.—Elements of Therapeutics and Materia Medica, 4th edit. Philadelphia, 1825.
Dr. Nuttall.—Lancet, vol. ix. p. 578.
H. M. Edwards and *P. Vavasseur*, M.D.—Manuel de Matière Médicale. Paris, 1826.—English Translation, by *Davis*. 1831.
C. Sundelin—Handbuch der speciellen Heilmittellehre, 2 Bde. 3te Aufl. 1833.
John Murray, M.D.—A System of Materia Medica and Pharmacy, 5th edit. Edinb. 1828.
A. Duncan, M.D.—Physiological Classification of the Materia Medica. In the Supplement to the New Dispensatory, 11th edit. 1829.
J. Wendt—Praktische Materia Medica. Breslau, 1830.—2te Aufl. 1833.
F. Foy—Cours de Pharmacologie, 2 tom. Paris, 1831.
A. T. Thomson, M.D.—Elements of Materia Medica and Therapeutics, 2 vols. 1832.—2d edit. in 1 vol. 1835.
E. S. and *K. D. Schroff*—Arzneimittellehre und Receptirkunde. Wien, 1833.
A. Trousseau et *H. Pidoux*—Traité de Thérapeutique, 1er tom. Paris, 1836; 2nd tom. 1re part, 1837; 2e part, 1839.—2e édit. 1841.
C. G. Mitscherlich—Lehrbuch der Arzneimittellehre, 1er Bd. 1837-1840; 2er Bd. 1846-1847, Berlin.

Carl Heinr. Schulze (*Schultzenstein*)—Natürliches System der allgemeinen Pharmakologie nach dem Wirkungsorganismus der Arznein, 8vo. Berlin, 1846.
F. Oesterlen—Handbuch der Arzneimittellehre, 8vo. Tübingen, 1845. 2te Aufl. 1847.
Dr. J. M. Neligan—Medicines, their Uses and Mode of Administration, 8vo. Dublin, 1844. 2d edition, 1847.

As examples of this kind of classification, I subjoin those of Duncan, Sundelin, C. G. Mitscherlich. and Schultz.

DR. DUNCAN'S PHYSIOLOGICAL CLASSIFICATION OF THE MATERIA MEDICA.

External agents act—

I. By nourishing the body .... ALIMENTA.
  (*a*) Drink .... Potus.
    When they act medicinally .... Diluentia.
  (*b*) Food .... Cibi.
    When they act medicinally .... Demulcentia.

II. By evacuation .... EVACUANTIA.
  (*a*) By the skin insensibly .... Diaphoretica.
    By the skin sensibly .... Sudorifica.
  (*b*) By the mucous membrane
    Of the nostrils .... Errhina.
    Of the lungs .... Expectorantia.
    Of the stomach .... Emetica.
    Of the intestines .... Cathartica.
    Of the uterus .... Emmenagoga.
  (*c*) By glandular secretion
    The kidneys .... Diuretica.
    The salivary glands .... Sialogoga.

III. By exciting the vital powers .... STIMULANTIA.
  (*a*) Chiefly of the parts to which they are applied TOPICA.
    Applied externally
      Causing redness .... Rubefacientia.
      Causing serous secretion .... Vesicantia.
      Causing purulent secretion .... Suppurantia.
    Administered internally
      Condimenta when alimentary
        When acting medicinally .... Carminativa.
  (*b*) Of the system generally .... GENERALIA.
    (*a*) Obscurely, but more durably ...... PERMANENTIA.
      Producing no immediate obvious effect .... Tonica.
      Constricting fibres and coagulating fluids .... Astringentia.
    (*b*) More evidently, but less durably... TRANSITORIA.
      Acting on the organic functions .... Calefacientia.
      Acting on the mental functions .... Inebriantia.

IV. By depressing the vital powers .... DEPRIMENTIA.
  Acting on the organic functions .... Refrigerantia.
  Acting on the mental functions .... Narcotica.

V. By chemical influence on the fluids .... CHEMICA.
  Acidifying .... Acida.
  Alkalizing .... Alkalina.

A very cursory examination of the substances placed by the author under each of the above classes will satisfy the most superficial observer, that this classification does not, in a large number of instances, effect that which it proposes to do; namely, to arrange together "substances according to the effects which they produce in a state of health." For example, under the head of diaphoretics and sudorifics we have mustard, copaiva, opium, ipecacuanha, alcohol, antimony, ammonia, and mercury; among narcotics are opium, nux vomica, foxglove, saffron, and colchicum; in the class sialogogues we have horseradish, tobacco, and mercury. Now, no one will pretend to affirm that the substances thus grouped together operate in an analogous manner on the system, or that their effects are similar.

SUNDELIN'S CLASSIFICATION.

A. AGENTS WHICH LESSEN VITALITY, AND ARE ADAPTED FOR AN ABNORMAL AUGMENTATION OF IT.	B. ALTERATIVE AGENTS ADAPTED FOR AN ALTERATION OF VITALITY.	C. AGENTS WHICH AUGMENT VITALITY, AND ARE ADAPTED FOR APPARENTLY OR ACTUALLY LESSENED VITALITY.
I. *Debilitating agents adapted for genuine hypersthenia.* *a.* Agents diminishing the blood and fluids. 1. Bloodletting. 2. Antiphlogistic purgatives. *b.* Debilitating agents in a limited sense—temperants. *c.* Agents which abstract heat.	I. *Resolvents adapted for an alteration of vitality from material causes.* *a.* Solvents. *b.* Absorbents. *c.* Liquefacients. *d.* Irritating resolvents. *e.* Strengthening resolvents. 1. Excitants. 2. Tonics.	I. *Irritants adapted for torpid debility.* *a.* Resolvents. *b.* Drastics. *c.* Acrids.
II. *Relaxants adapted for abnormal tension of fibre, and for augmented irritability and sensibility.* *a.* Oleaginous substances. *b.* Mucilaginous, amylaceous, and albuminous substances. *c.* Saccharine substances.	II. *Evacuants adapted for retentions.* *a.* Emetics. *b.* Purgatives. *c.* Emmenagogues. *d.* Diuretics. *e.* Diaphoretics. *f.* Diaphoretico-diuretics, or the so-called purifiers of the blood. *g.* Cutaneous irritants. *h.* Anthelmintics.	II. *Strengthening agents adapted for true debility.* *a.* Animating, analeptics. *b.* Exciting - animating agents. *c.* Exciting-strengthening agents. 1. Carminatives. 2. Aromatic herbs. 3. Powerful excitants. 4. Balsamics. 5. Irritating excitants. 6. Empyreumatic agents. 7. Spices. 8. Exciting irritants. *d.* Tonics. 1. Consolidating agents. 2. Tonic bitters. 3. Astringents. 4. Antiseptics. 5. Exciting tonics.
	III. *Alteratives adapted for altered sensibility and irritability.* *a.* Narcotics adapted for hyperæsthesis and convulsibility. 1. Depressing narcotics. 2. Exciting narcotics. 3. Resolvent-acronarcotics. 4. Acronarcotics. 5. Bitter poisonous narcotics. 6. Metallic substances.	

In this classification, the author assumes that medicines act in one of three ways only, viz. by lessening, by altering, or by augmenting vitality (see *ante*, p. 101). There is, therefore, in this arrangement, no place for agents which act simultaneously in two of these three ways: for example, by both altering and augmenting vital action. This defect leads the author into many errors in the details of his classification; and it will be found that most of the agents placed in the third division (C) are, in reality, referable to the second division (B), on account of their alterative action.

DR. C. G. MITSCHERLICH'S CLASSIFICATION.

1st Class—Medicamenta tonica.

Order I. Amara.
 II. Adstringentia.
 III. Ferri præparata.
  Appendix—Manganesii præparata.
 IV. Frigus.

2d Class—Medicamenta emollientia et nutrientia.

Order I. Mucilaginosa.
 II. Amylacea.
 III. Pinguia et oleosa.
 IV. Albuminosa et caseosa.
 V. Gelatinosa.
 VI. Saccharina.
 VII. Calor humidus.

3d Class—Medicamenta excitantia.

Order I. Tonico-excitantia.
 II. Excitants which promote digestion.
 III. Excitants which promote the secretions and excretions.
 IV. Excitants which affect the brain and spinal cord.
 V. Calor siccus.
  Appendix—Camphor, arnica, sulphur, carburet of sulphur, empyreumatic oils, electricity.

4th Class—Medicamenta acria.

Order I. Aromata acria.
 II. Emetica acria.
 III. Cathartica drastica seu acria.
 IV. Diuretica acria.
 V. Narcotico-acria.
  [*Emmenagoga acria* are made a distinct order in the introduction; but in the subsequent division of the classes they are omitted.]

5th Class—Medicamenta temperantia.

Order I. Acida temperantia.
 II. Acida tonica-temperantia.

6th Class—Medicamenta solventia.

Order I. Caustica alkalina.
 II. Salia media.

7th Class—Medicamenta narcotica.

Order I. Agents which paralyse the activity of the whole nervous system (e. g. *acidum hydrocyanicum*).
 II. Agents which especially act on the spinal marrow, and at first increase but soon interrupt sensation and motion (e. g. *nux vomica*).
 III. Agents which especially interrupt the function of the brain, and also that of the spinal cord and sympathetic nerves (e. g. *hyoscyamus* and *belladonna*).
 IV. Agents which at first change and at last stupify the peculiar activity of the brain, interrupt the function of the spinal cord, and at the same time act as powerful alteratives on the sympathetic nerves (e. g. *opium*).
 V. Narcotico-acria (e. g. *digitalis*).
  Appendix—Medicamenta mentem deprimentia et alterantia (psychica).

8th Class—Medicamenta alterantia.

Order I. The earths and their compounds.
 II. The metals and their compounds.

9th Class—Medicamenta incertæ sedis.

The first part of Dr. Mitscherlich's work, in which he gave an outline of his proposed classification, was published in 1837. Several other parts, embracing descriptions of the first, second, third, and fourth classes, have subsequently appeared; and in these he has somewhat modified the subdivisions of the first four classes. These modifications I have embodied in the above table. The five latter classes remain as they were produced in 1837.

Dr. C. H. Schultz's classification.—The most extraordinary modern classification is that of Dr. C. H. Schultz, of which the following is an outline:—

DR. C. H. SCHULTZ'S CLASSIFICATION.

A. BIOLYTICA. Their action tends to the dissolution of life and structure (*dissolventia organica*). They weaken and disorganize, and are opposed to organization and assimilation. *Venena.*	1. *Plastilytica.* For vegetative life. Metals, haloids.	1. *P. morpholytica.* Acting chiefly on the morbid vegetation of cells, bones, and glands.	The colliquescent metals: mercury, antimony.
		2. *P. haematica.* Acting chiefly on the blood and vessels.	The caustic irritating metals: copper, arsenic, silver, gold.
		3. *P. myotica.* Acting chiefly on the muscles and nerves.	The astringent metals: iron, lead, zinc, bismuth.
		4. *P. lymphatica.* Acting chiefly on the lymphatic system. They check both decomposition and assimilation.	Iodine, bromine, chlorine, carbon.
	2. *Erethilytica* (Haematolytica). Acids, salts, mucus.	1. *H. physoda.* Acting on the blood-corpuscles.	Mineral acids, vegetable acids.
		2. *H. plasmatoda.* Acting on the blood-plasma.	Alkaline and earthy salts, mucus.
	3. *Neurolytica.*	1. *Phrenolytica.* Acting chiefly on the brain.	Prussic acid, stramonium, hyoscyamus, belladonna, dulcamara, nicotiana, amanita muscaria.
		2. *Aesthesilytica.* Senses-narcotics (paralyzing feeling and allaying pain).	Aconitum, pulsatilla, helleborus niger, clematis, primulaceæ, secale cornutum.
		3. *Myelolytica.* Excitoparalytica.	Conium, cicuta, phellandrium, digitalis, and other scrophularineæ.
B. ANABIOTICA. Their action tends to the increase of vitality, of organization, and of animation. They therefore preserve (*continentia*), organize, and strengthen.	4. *Plastibiotica.*	1. *P. anapeptica.* Influencing assimilation.	Amara.
		2. *P. anatrophica.*	Gelatinosa, albuminosa, oleosa, farinosa.
		3. *P. myotica* (anerethica) Action chiefly on the irritable organs.	Adstringentia vegetabilia.
	5. *Erethibiotica* (Haematobiotica). Aethereo-oleosa.	1. *E. anapeptica* (homoeotica). Action chiefly on the digestive organs and sanguification.	Volatile oil, combined with bitter and astringent substances, aromatica, cinnamon, cloves, ginger, &c.
		2. *E. pneumatoda* (physoda). Action chiefly on the blood-corpuscles, the lungs, and heart.	The mint-like volatile oils of labiatæ, the valerianæ, many compositæ.
		3. *E. neuroda.* Action through the blood on the nerves.	Volatile oil in combination with resin, bals. peruvianum, b. copaivæ, myrrha, olibanum, benzoin, gum-resins of umbelliferæ.
	6. *Neurobiotica.*	1. *Phrenobiotica.*	Opium, cannabis, humulus, ether, alcohol, wine.
		2. *Myelobiotica.* Excitocontractoria.	Strychneæ, nuxvomica, ignatia. Menispermeæ, cocculus, columbo: coriaria myrtifolia.
		3. *Aesthesibiotica.*	Moschus, castoreum, ammoniacalia, empyreumatica.
C. AGONISTICA. Their action tends to the production of a defensive process, as in diseases. They excite artificial fever, inflammations, and vomitings, with attempts at expulsion. *Vis expellens, drastica* opposed to *vis continens.* (*Apolytica.*)	7. *Plastagonistica.*	1. *P. enteragoga.* Laxantia, sialagoga (stomatagoga), cholagoga.	Senna, tamarinds, manna, geoffroya, jalapa.
		2. *P. dermatagoga.* Sudorifics.	Sambucus, jacea, ammoniacal salts.
		3. *P. nephragoga.* Diuretics.	Alkalis, sapones, saponaria, sarza, carex arenaria.
	8. *Erethagonistica.* Acria.	1. *E. phlogoga.* Rubefacientia, urentia, suppurantia.	Euphorbiaceæ, thymeleæ (mezereon), meloes majales, cantharides, phosphorus, veratrineæ (veratrum album, colchicum), cruciferæ (sinapis cochlearia), piperineæ (cubebæ).
		2. *E. haematagoga.*	Toxicodendron, asarum, aristolochia, taxus, sabina, juniperus, crocus, aloë, allium, sulphur.
	9. *Neuragonistica.* (Neuropolytica).	1. *Pneumonapolytica.* (Expectorantia, errhina).	Senega, arnica, pyrethrum acmella, scilla, arum, r. ireos.
		2. *Enteropolytica.* Gastrapolytica (emetica). calicapolytica (tenesmica, eccoprotica).	Ipecacuanha, cainana, cucurbitaceæ (elaterium bryonia, colocynthis), guttiferæ.

2. According to Brunonian Principles.

Some physicians have classified the articles of the Materia Medica in accordance with *Brunonian principles.* I have before (see p. 99) stated that Brown regarded all medicines as stimulants; that is, as agents causing excitment. But he supposed some of them to produce less excitment than is requisite for health; and, therefore, to be the remedies for sthenic diathesis: hence they were termed *debilitating* or *antisthenic.* On the other hand, some agents give more excitement than suits the healthy state; and are, therefore, the remedies for the asthenic diathesis. These he called *stimulant* or *sthenic.*[1] The following pharmacological works are based on Brunonian principles[2]:—

Versuch einer einfachen praktischen Arzneimittellehre. Wien, 1797.
Pharmacopœia Browniana, oder Handbuch der einfachsten und Wirksamsten Heilmittel, mit klinischen Bemerkungen im Geiste der geläuterten neuen Arzneilehre. Stuttgart, 1798.
J. *S. Frank*—Versuch einer theoretisch-praktischen Arzneimittellehre nach den Grundsätzen der Erregungstheorie. Erlangen, 1802. 2 Aufl. Wien, 1804.
C. F. Oberreich—Umriss einer Arzneimittellehre nach den Grundsätzen der Erregungstheorie. Leigzpi, 1803.
J. J. Chortet.—Traité de Pharmacologie, basée sur la théorie de Brown. Paris, 1806.
F. Wurzer—Grundriss der Arzneimittellehre. Leipzig, 1808.
J. H. Müller—Handbuch der Lebens- und Arzneimittellehre. Leipzig, 1809.
J. A. Neurohr—Versuch einer einfachen praktischen Arzneimittellehre. Zweite Aufl. Heidelberg, 1811.
K. Schöne—Praktische Arzneimittellehre für Aerzte und Wundärzte nach den Grundsätzen der Erregungstheorie. 2 Bde. Berlin, 1815.

3. According to the Doctrine of Contra-Stimulus.

In the following work, the articles of the Materia Medica are arranged according to the doctrine of contra-stimulus:—

G. Giacomini—Trattato filosofico-sperimentale dei soccorsi terapeutici. 4 vols. 8vo. Padova, 1833-36.

GIACOMINI'S CLASSIFICATION.

Class I. *Hypersthenics.*

Order 1. *Cardiaco-vasculo-hypersthenics:* ammonia and its carbonate.
Order 2. *Vasculo-cardiac hypersthenics:* the ethers.
Order 3. *Cephalic hypersthenics:* opium, morphia, and narcotina.
Order 4. *Spinal hypersthenics:* alcohol, rum, cherry-spirit, and wine.
Order 5. *Gastro-enteric hypersthenics:* volatile oils, cinnamon, cloves, and nutmegs.

Class II. *Hyposthenics or Contra-stimulants.*

Order 1. *Cardiaco-vasculo-hyposthenics:* hydrocyanic acid, laurel water, bitter almonds, peach leaves and flowers, black cherries, cantharides, digitalis, squills, colchicum, white hellebore, cebadilla, camphor, peppermint, sage, chamomile, Venice turpentine, balsam of copaiva, juniper, carbonic acid, nitre, acetate of potash, and asparagus.
Order 2. *Vasculo-cardiac hyposthenics:*
    Sect. 1. *Arterial vasculo-hyposthenics:* antimonials, aconite, ipecacuanha, elder flowers, dulcamara, sarsaparilla, guaiacum, sulphur, sulphuret of potash, sulphuretted mineral waters, ergot of rye, cinchona, willow bark, Iceland moss, and iron.

---

[1] *The Works of Dr. John Brown*, vol. ii. p. 205, 1804.
[2] *Encyclopädisches Wörterbuch der medicinischen Wissenschaften*, 3 Bd. art. *Arzneimittellehre.*

Sect. 2. *Venous vasculo-hyposthenics:* sulphuric, nitric, hydrochloric, and nitro-hydrochloric acids, chlorine, oxalic, citric, acetic, and boracic acids, mustard, and scurvy-grass.

Order 3. *Lymphatico-glandulo-hyposthenics;* mercurials, iodine, burnt sponge, bromine, chloride of barium, and hemlock.

Order 4. *Gastric hyposthenics:* bismuth, quassia, calumba, wormwood, wormseed, gentian, taraxacum, and bitters.

Order 5. *Enteritic hyposthenics:* tamarinds, cassia, prunes, manna, fixed oils of almonds, olives, linseed, and castor, cream of tartar, sulphates of magnesia, potash, and soda, carbonate of magnesia, senna, rhubarb, jalap, aloes, scammony, purgative elixir, gamboge, and the oils of caper spurge and croton.

Order 6. *Cephalic hyposthenics:* belladonna, stramonium, henbane, and tobacco.

Order 7. *Spinal hyposthenics:* strychnia, nux vomica, St. Iguatius's bean, toxicodendron, lead, arnica, assafœtida, and valerian.

Andral[1], who quotes Fanzago, Tommasina, and Gozzi, says that the Italians divide medicines into two classes, *dynamics* and *irritants*. The first comprehends those agents which augment or depress excitability,—stimulants and contra-stimulants; the second includes mechanical and chemical agents.

4. According to the Doctrine of Broussais.

The followers of Broussais, the founder of what the French denominate the *New Medical Doctrine*, or *Physiological Medicine,* consider all medicines to be either stimulants or debilitants. When a stimulant is applied to the affected organ, it is termed a direct stimulant; but when applied to a part more or less distant from that affected, it is termed a revulsive, or sometimes an indirect debilitant. Hence medicines are divided into *debilitants, direct stimulants,* and *revulsives*. This is the plan adopted in the following work:—

L. J. Begin—Traité de Thérapeutique, rédigé d'après les principes de la nouvelle Doctrine Médicale, t. ii. Paris, 1825.

5. According to Chemico-Physiological Principles.

Another mode of classifying medicines is on *chemico-physiological principles;* or, to use the phrase of Dr. Osanna[2], "on the chemico-therapeutical basis of natural philosophy." This method has been adopted in the following works:—

K. F. Burdach—System der Arzneimittellehre, 1807-9. 3 Bde. 2te Aufl. 1817-19. Leipzig.

C. H. C. Bischoff—Die Lehre von den chemischen Heilmitteln, oder Handbuch der Arzneimittellehre. 3 Bde. Bonn, 1825-31. [I have given a sketch of this classification in the *London Medical Gazette*, vol. xvii. p. 164.]

W. Graban, M.D.—Chemisch-physiologisches System der Pharmakodynamik. 1er Theil: Kiel, 1837. 2er Theil: Kiel, 1838.

6. According to the Part affected.

Another mode of classifying medicines is to arrange them according to the *particular structure or organ which they affect;* as into medicines acting specifically on the nervous system; medicines acting specifically on the vascular system, and so on. Some authors have formed their principal divisions, or classes of medicines, from the parts acted on; and their orders, from the nature or quality of the effect.

---

[1] *Dict de Méd. et de Chirurg. pratiq.* art. *Contre-Stimulant.*

[2] *Encyclop. Wörterb. d. med. Wissenschaften.*

The following writers have followed this order of classification :—

J. L. Alibert—Nouveaux Elémens de Thérapeutique et de Matière Médicale, 5me éd. 3 t. Paris, 1826. [I have given a sketch of this classification in the *London Medical Gazette*, vol. xvii. p. 165.]

Dr. Granville—Medical and Physical Journal, for April 1822, vol. xlvii.

J. Eberle, M.D.—A Treatise on Materia Medica and Therapeutics, 2d ed. Philadelphia, 1824; 3d edit. 1825.

Ph. F. W. Vogt—Lehrbuch der Pharmakodynamik. 2 Bde. 2te Aufl. 1828; 3te Aufl. 1832. 4 Ausg. Giessen, 1843.

Dr. Michaelis—Encyclopädisches Wörterbuch der medicinischen Wissenschaften. Art. Arzneimittel. Berlin, 1829.

EBERLE'S CLASSIFICATION.

A.—Medicines that act specially on the intestinal canal, or upon morbific matter lodged in it	I. Medicines that excite discharges from the alimentary canal	Emetics. Cathartics.
	II. Medicines calculated to destroy or counteract the influence of morbific substances lodged in the alimentary canal..........	Anthelmintics. Antacids.
B.—Medicines whose action is principally directed to the muscular system	I. Medicines calculated to correct certain morbid conditions of the system, by acting on the tonicity of the muscular fibre	Tonics.
	II. Medicines calculated to correct certain morbid states of the system, by acting on the contractility of the muscular fibre	Astringents.
C.—Medicines that act specifically on the uterine system	I. Medicines calculated to promote the menstrual discharge	Emmenagogues.
	II. Medicines calculated to increase the parturient efforts of the womb	Abortiva.
D.—Medicines that act specifically on the nervous system	I. Medicines that lessen the sensibility and irritability of the nervous system	Narcotics.
	II. Medicines that increase and equalise the nervous energy..........................	Antispasmodics.
E.—Medicines whose action is principally manifested in the circulatory system	I. Medicines that increase the action of the heart and arteries.........................	Stimulants.
F.—Medicines acting specifically upon the organs of secretion	I. Medicines that act on the cutaneous exhalents ... general	Diaphoretics.
	topical	Epispastics. Errhines. Emollients.
	II. Medicines that increase the action of the urinary organs	Diuretics.
	III. Medicines that alter the state of the urinary secretion	Antilithics.
	IV. Medicines that promote the secretory action of the salivary glands...............	Sialagogues.
G.—Medicines that act specifically upon the respiratory organs	I. Medicines calculated to increase the mucous secretion in the bronchia, and to promote its discharge	Expectorants. Inhalants.
	II. Medicines whose action is truly topical ...	Emollients. Escharotics.

VOGT'S CLASSIFICATION.

Vogt makes three classes of medicines: the first including those agents which specially affect the *sensibility* of the body, the second containing those which alter the *irritability* of the system, and the third embracing those agents which influence what he calls the *vegetation* of the body—that is, the organic functions; namely, nutrition and reproduction.

	ORDERS..	DIVISIONS.
CLASS I. *Medicines operating specially on the nervous system, and particularly used as nervous agents*	1. Medicines which limit the vital manifestation of the nervous system (*narcotica*)	1. Opium and its allies.
		2. Nux vomica and medicines similar to it.
		3. Hydrocyanic acid, and vegetables allied to it.
		4. Belladonna, amd medicines similar to it.
	2. Medicines which exalt and strengthen the vital manifestations of the nervous system (*nervina*)	1. Nervina volatilia (ammonia, musk, &c.)
		2. Nervino-alterantia; antispasmodica (ipecacuanha, copper, zinc, bismuth, &c.)
CLASS II. *Medicines operating specially on irritable life*	1. Weakening(*antiphlogistica*)	as the neutral salts, cold, &c.
	2. Medicines which heighten and strengthen the vital manifestations of the irritable system	1. Excitantia volatilia (as camphor, mints, &c.)
		2. Tonica.
		3. Antiseptica (acids, chlorine, &c.)
CLASS III. *Medicines operating specially on the vegetable* [organic] *system, and which are particularly used in diseases of vegetation* [nutrition and reproduction]	1. Medicines operating specially on the secreting and excreting systems	1. Heat.
		2. Gummi-resinosa, balsamica, and resinosa.
		3. Resolventia (acrids, mercury, antimony, sulphur, alkalies, iodine, &c.)
	2. Medicines which specially operate on the formative process	1. Aromata (pepper, pyrethrum, nutmegs, &c.)
		2. Nutrientia.

ε. Classifications founded on Therapeutical Properties.

The curative and remedial powers of medicines are not absolute and constant, but relative and conditional; so that we have no substance which, under every circumstance, is a remedy for a particular disease. This will explain why no modern author has attempted to classify remedies according to their therapeutical properties. Such a classification, if attempted, must be an arrangement of diseases, and an enumeration of the medicines which experience had found frequently, though not invariably, beneficial for each. On this principle, an *Index of Diseases and of Remedies according to the opinions of the ancient Greeks, Latins, and Arabs,* has been given in the following work :—

J. Rutty, M.D.—Materia Medica antiqua et nova, repurgata et illustrata, 4to. Rotterodami, 1775.

Strictly speaking, therefore, there are no substances to which the term *specifics* (*specifica qualitativa*, Hufeland[1]) can be properly applied. Yet it cannot be denied that there are many medicines which are particularly appropriated to the cure of certain diseases, or to the relief of particular symptoms; experience having shown that they more frequently give relief than other agents. As examples I may refer to the use of mercury in syphilis, disulphate of quina in ague, arsenious acid in lepra, and hydrocyanic acid in vomiting and gastrodynia. Moreover, I cannot admit that any satisfactory explanation has yet been given of the *modus medendi* of many of these agents. The relief obtained in constipation by the use of senna, and in pain by that of opium, is explicable by reference to the known physiological effects of these substances. But the benefit procured in venereal diseases by mercury, in ague by disulphate of quina, &c. cannot be accounted for by reference to any known physiological effects which these substances produce, and our use of them, therefore, is at present empirical. It cannot, however, be doubted that had we a more intimate acquaintance with, and precise knowledge of, the action of remedies, the therapeutical properties of medicines would no longer appear incomprehensible and mysterious.

---

[1] *Lehrbuch der allgemeinen Heilkunde*, S. 194, 2te Aufl. Jena, 1830.

Though no systematic therapeutical classification has, to my knowledge, been attempted by modern authors, yet in some recent works several therapeutical classes have been admitted; especially in the following .—

F. Foy, M.D.—Cours de Pharmacologie, 2 tomes. Paris, 1831. [His class of specifics includes antisyphilitics, antipsorics, febrifuges, or antiperiodics, antiscrofulous medicines, and anthelmintics.]

J. H. Dierbach, M.D.—Die neuesten Entdeckungen in der Materia Medica, 2te Ausg. 1er Band. Heidelberg und Leipzig, 1837.

7. Physiological Classes of Medicines.

I have already (p. 149) expressed my opinion that, in the present state of our knowledge, a physiological classification of medicines cannot be satisfactorily effected. It is principally on this ground that I have thought it advisable, in the following pages, not to follow this kind of arrangement; though it appears to me advisable to precede the account of medicines individually, by some notice of the more important groups which they form when arranged on physiological principles.

In doing this, I shall adopt the following arrangement:—

	MEDICAMENTA.
1. Medicines employed for their external or topical effects	*Topica.*
α Acting mechanically	Class 1, T. Mechanica.
β. Acting chemically	Class 2, T. Chemica.
γ. Acting dynamically	Class 3, T. Dynamica.
2. Medicines employed for their remote or general effects.	*Generalia*[1].
α. Acting on the blood	Class 4, Hæmatica.
β. Acting on the respiratory organs . . .	Class 5, Pneumatica.
γ. Acting on the nervous system	Class 6, Neurotica.
δ. Acting on the digestive organs	Class 7, Cœliaca.
ε. Acting on the excernent system	Class 8, Eccritica.
ζ. Acting on the sexual organs	Class 9, Genetica.

Class I. *Topica Mechanica.* Topical Medicines acting Mechanically.

These are topical remedies which operate therapeutically by a physical or mechanical agency.

This class includes mechanical antidotes, some purgatives and anthelmintics, and dentifrices.

ORDER 1. MECHANICAL ANTIDOTES.—In poisoning by caustic or acrid substances, considerable relief is generally obtained by the use of diluents, oily, mucilaginous, and other demulcent liquids, and fine impalpable powders. These substances lessen the injurious action of poisons by diluting and enveloping them, by sheathing the mucous surface of the stomach and intestines, and by obstructing absorption. Hence I have termed them mechanical antidotes.

---

[1] The names given to the classes of the *generalia* are those used by Dr. Good, in his *Physiological System of Nosology*, to designate classes of disease.

Demulcentia.

Aqua.
Mucilaginosa.
Farinosa.
Saccharina.
Gelatinosa.
Albuminosa.
Oleosa.

Pulveres.

Carbo animalis.
Carbo ligni.
Farina.
Ferri sesquioxydum.
Magnesia.

Some of these agents act, in particular cases, as chemical antidotes also, (see Class II. CHEMICA).

ORDER 2. PURGATIVES AND ANTHELMINTICS ACTING MECHANICALLY.—Some few medicinal agents, occasionally used as purgatives and anthelmintics, are employed on account of their mechanical influence. Three only require to be mentioned.

Hydrargyrum.
Stanni pulvis.
Mucuna pruriens—*Setæ.*

Metallic mercury is employed as a cathartic in alvine obstructions; while powdered tin and the hairs of the pods of cowhage are used as vermifuges. The first acts by its gravity; while the third, and perhaps the second also, operate as mechanical irritants.

ORDER 3. DENTIFRICES (*dentifrici; ὀδοντόσμηγμα; ὀδοντότριμμα*) are mechanical agents, usually powders, employed for cleansing the teeth. They were in use among the Greeks and Romans.[1] The following substances form the bases of most of the dentifrices now in use:—

Pumex.
Bolus armeniaca.[2]
Creta.
Os sepiæ.
Sodii chloridum.
Potassæ bitartras.
Myrrha.
Cinchonæ cortex.
Iridis florentinæ radix.
Sanguis draconis.
Catechu.

Tooth powders require to have a certain degree of hardness or grittiness to enable them to remove the foreign matters adherent to the teeth, but, if too hard, they are injurious to the enamel. Pumice powder is too gritty for frequent use. Employed occasionally (say once in two or three months) it is serviceable. Charcoal and cuttlefish bone powder are good detergents. Chalk is very soft. Rhatany, cinchona, and catechu, are useful astringents. Myrrh is employed partly for its odour. All insoluble powders, however, are more or less objectionable, since they are apt to accumulate in the space formed by the fold of the gum and the neck of the tooth, and thus present a coloured circle. To hide this many tooth powders are coloured red with bole armeniac. The soluble substances which may be used as tooth powders are,—sulphate of potash, phosphate of soda, bitartrate of potash, and common salt.

Disinfecting and decolorizing tooth powders, washes, and lozenges, owe their efficacy to chloride of lime, and are used to destroy the unpleasant odour of the breath, and restore the white colour of the teeth when stained by tobacco[3], &c. Thus, one part of chloride of lime may be added to twenty or thirty parts of chalk, and used as a decolorizing tooth powder. A disinfecting mouth-wash is prepared by digesting three drachms of chloride of lime in two ounces of distilled water; and, to the filtered solution, adding two ounces of spirit, to which some scent (as otto of roses) has been added.

---

[1] Galen, *De Compos. Medicam. secundum locos*, lib. v.; also, *Paulus Ægineta*, translated by Mr. Adams, vol. i. p. 455, et seq. Syd. Soc. 1844.

[2] The substance sold in the shops under this name is an artificial mixture of pipe-clay and sesquioxide of iron.

[3] *Journal de Chimie Médicale*, t. iii. p. 494; and t. iv. p. 28.

Class II. *Topica Chemica.* Topical Medicines acting Chemically.

This class includes those chemical agents which are employed in medicine as topical medicines.

We may divide them, according to the purposes for which they are used, into four orders; viz. *caustics*, *astringents*, *antidotes*, and *disinfectants*.

HAIR DYES (*tincturæ capillorum*; βαφαὶ τριχῶν; βάμματα τριχῶν) are chemical agents; but they are included in this class, because their employment usually devolves on the hair-dresser. Yet, occasionally, a knowledge of them is useful to the medical practitioner. "Galen, when about to treat of compositions for the hair, remarks that the application of these does not belong properly to the physician; but that he may sometimes be obliged to furnish them to *royal ladies*, whom, under certain circumstances, he cannot venture to disobey."[1]

Hair dyes were in use by the ladies of antiquity;[2] and numerous recipes for their preparation are to be found in ancient medical authors.[3]

Various substances,—some mineral, others vegetable,—have been used as hair dyes. The base of most of the powders, pastes, and liquids sold in the shops, is either lead or silver. A mixture of finely-powdered litharge or carbonate of lead, and about an equal weight of slaked lime (to which starch is sometimes added) is frequently used.[4] It is then put on to prevent evaporation, and in four or five hours is removed, and the dye washed out. The water causes the oxide of lead to unite with the lime, forming a plumbite of lime. The lime is useful by removing the grease of the hair, while the lead combines with the sulphur contained in the hair, and forms the black sulphuret of lead. Leaden combs act on the same principle. Nitrate of silver is also extensively used as a hair dye. Hair, impregnated with a solution of this salt, blackens, partly by the reduction of the silver, partly by the formation of the black sulphuret of silver. Sometimes a solution of hydrosulphuret of ammonia, to which caustic potash has been added, is applied to the hair previous to the use of the nitrate, but a solution of gallic acid is preferable, and acts better than the hydrosulphuret. Other formulæ for hair dyes have been published.[5] The objections to the use of mineral hair dyes are, that they commonly communicate a reddish or purplish tint, and render the hair dry, crisp, and brittle.

Various vegetable substances have been employed; as the green shells of walnuts (*cortex nucum juglandis viridis*). These are used in the form of decoction, or of the so-called walnut liquor. The "Tinctur zum Schwarzfärben der Haare" is an alcoholic tincture of these shells scented with oil of lavender.[6] Pyro-gallic acid has recently been proposed as a hair dye.[7]

The detection of stained hair is sometimes an object of medico-legal research.[8] Lead may be recognised in hair by boiling the latter in nitric acid, and applying the tests for lead to the nitric solution. To detect silver, the hair must be treated with chlorine, to form chloride of silver, which is soluble in ammonia. From the ammoniacal solution the chloride may be precipitated by nitric acid, and its nature ascertained by the usual means.

---

[1] *Paulus Ægineta*, translated by Mr. Adams, for the Sydenham Society, vol. i. pp.342-4, 1844.—See also Galen, *De Compos. Medicam. secundum locos*, lib. i.

[2] Medea is said to have been acquainted with the art of dyeing grey hairs black, and partly in consequence of this she had the reputation of being able to restore youth to old people.

[3] *Galen*, supra cit.; *Paulus*, supra cit.; and *Alexander Trallianus*, i. 3.

[4] The use of a composition of this kind, called *Poudre d'Italie*, is said to have produced ophthalmia (*Lond. Med. Gaz.* Nov. 18, 1842).

[5] See Gray's *Supplement to the Pharmacopœia*, by Mr. Redwood, p. 740, Lond. 1847. Also, *Journal de Chimie Médicale*, tom. ii. p. 250, 2nde sér.

[6] Phœbus, *Handbuch der Arzneiverordnungs-lehre*, Th. ii. p. 148, 3tte Ausgabe, 1840.

[7] *Pharmaceutical Journal*, vol. iii. p. 585.

[8] Devergie, *Médecine Legale*, t. ii. p. 931, Paris, 1836; and Dr. Cummin, *Lond. Med. Gaz.* vol. xix. p. 215.

ORDER 1. CAUSTICA. *Cauteria potentialia.*—Chemical agents which destroy animal tissues and decompose interposed animal fluids are called *caustics* (from καίω, *I burn*). The chemical changes which the tissues and these agents respectively suffer, when they come in contact, have been before adverted to (see pp. 93, 97-98). Remote or constitutional effects sometimes arise from the employment of caustics: they are in general produced by nervous agency (see pp. 117, 118); but, in the case of the mercurial and arsenical preparations, they may be the result of absorption.

Caustics are conveniently grouped in two sub-orders—escharotica and cathæretica.

Sub-order 1. *Escharotica.*—The stronger caustics, which effect the complete destruction of the parts to which they are applied, and which give rise to the formation of an eschar, are called *escharotics* (from ἐσχάρα, an eschar,) or *corrosives*. They destroy both the structure and life of a part (morpholysis and biolysis. See p. 98). The eschar is succeeded by inflammation and suppuration in subjacent tissues, by which the slough is separated from the living parts.

The escharotics in most frequent use are—

Acidum sulphuricum.
Acidum nitricum.
Potassa.
Antimonii terchloridum.
Zinci chloridum.

They are employed—

1. To effect the destruction of living parts: thus to remove excrescences or morbid growths of various kinds,—such as warts, condylomata, some kinds of polypi, malignant growths, and spongy granulations; to form issues; and to open abscesses.

2. To decompose the virus of rabid animals, and the venom of the viper and other poisonous serpents.

Sub-order 2. *Cathæretica.*—The milder caustics, which enter into chemical combination with the tissues and decompose the animal fluids, are called *cathæretics* (from καθαιρέω, *I destroy*). They do not effect that complete destruction of parts which the escharotics do. Those in most frequent use are as follows:—

Iodinium.
Calx viva.
Liquor ammoniæ.
Arsenici tersulphuretum.
Acidum arseniosum.
Hydrargyri binoxydum.
Hydrargyri bichloridum.
Argenti nitras.
Cupri sulphas.
Cupri diacetas.
Zinci sulphas.
Zinci acetas.
Plumbi oxydum.
Plumbi acetas.
Alum.
Acidum aceticum.
Creasoton.

Cathæretics, besides entering into chemical combination with the tissues to which they are applied, frequently alter the living actions going on in subjacent parts. They are used for various purposes, of which the following are the principal:—

1. To effect the destruction or removal of parts,—as warts, hairs, &c.

EPILATORIES or DEPILATORIES (*depilatoria; psilothra*, ψίλωθρα, from ψιλόω, *I make bald*), or medicines for removing hair from the skin, were in use among the ancients[1]

---

[1] Galen, *De Compos. Medicam. secundum locos*, lib. i.; *Paulus Ægineta*, translated by Mr. Adams, vol. i. pp. 342 and 588.

They were frequently employed for immodest purposes. In modern times they have been used as cosmetics to remove superfluous hairs from the face, and as medicines to remove the hair from the scalp in the treatment of porrigo favosa. Lime or orpiment (tersulphuret of arsenic) are the constituents of most of the ancient depilatories as well as of the modern ones sold by perfumers as cosmetics, including the Turkish *rusma*. But the use of orpiment is dangerous, especially when the skin is abraded. The best and safest depilatory for cosmetic purposes is said[1] to be "a strong solution of sulphuret of barium, made into a paste with powdered starch." It should be applied to the hair immediately after it is mixed, and allowed to remain there for five or ten minutes.

The alkalies are generally used for removing the hair in the treatment of porrigo favosa. Cazenave's *pommade épilatoire*[2] (an obvious imitation of the secret preparation of Messrs. Mahon) is as follows:—Carbonate of soda, 10 parts; lime, 5 parts; and lard, 40 parts. Mix.

2. To alter the action of subjacent parts. Most cathæretics are practically useful in this way: they effect a chemical change in the superficial parts, and alter the morbid action in subjacent ones. The employment of arsenious acid in lupus; of sulphate of copper and nitrate of silver in promoting the cicatrization of ulcers; of solutions of several metallic salts in inflammatory and other affections of the mucous membranes (as in mucous and purulent ophthalmia, gonorrhœa, &c.); of tincture of iodine applied to the skin over joints affected with rheumatic or gouty inflammation; and of nitrate of silver in erysipelas—are examples of this use of cathæretics.

3. To stop hemorrhage from numerous small vessels. Cathæretics act as styptics, in part by causing contraction of the vessels, but principally by coagulating the blood.

Order 2. Astringentia.—These are chemical agents which constrict fibres and coagulate albuminous fluids. When employed to obviate relaxation of fibres and tissues, and to check excessive secretion, they are called ***astringents***; but, when used to repress hemorrhage, they are termed ***styptics*** (***styptica***). Those astringents which are employed to check secretion and exhalation, and which exercise but little corrugating power over the solids, are denominated ***desiccants*** (***desiccantia***).

The following is a list of the most frequently employed astringents:—

Zinci oxydum.
Zinci carbonas.
Zinci sulphas.
Zinci acetas.
Plumbi acetas.
Plumbi diacetas.
Ferri sulphas.
Ferri sesquichloridum.
Cupri sulphas.
Hydrargyri bichloridum.
Argenti nitras.
Alum.
Calx.
Acidum tannicum.
Vegetabilia tannica.[3]
Alcohol.

The astringents are, in fact, cathæretics acting in a milder and more dilute form. All of them react chemically on the animal solids and fluids. The chemical changes which take place have been already noticed (see pp. 93 and 97). Astringents are not mere chemical agents: they operate dynamically also, and are powerful topical stimulants or excitants. But this dynamical influence, on which their utility as medicinal agents depends, is apparently a consequence of their chemical action (see pp. 94 and 98).

The general indications for the use of the astringents are atony and relaxation of the solid parts, with profuse secretion. The general contra-indications for their use are, rigidity and hardness of the solids, great irritation or inflammation, and dryness of secreting surfaces.

---

[1] Gray's *Supplement*, by Redwood, p. 737, 1847.

[2] Bouchardat, *Nouveau Formulaire Magistral*, p. 354, 3me édit. 1845.

[3] A list of the vegetable astringents containing tannic acid will be given hereafter (see *Tonics*).

As topical remedies, they are employed for the following purposes :—

1. To stop preternatural secretion from mucous surfaces : as in leucorrhœa, gonorrhœa, and gleet.
2. To check profuse secretion from ulcerated surfaces.
3. To stop hemorrhage ; as from the uterus and piles.
4. To strengthen and constringe relaxed parts ; as in prolapsus.
5. To subdue inflammation of superficial parts. When used for this purpose, they are sometimes called *repellents* or *repercussives* (*repellentia* seu *repercutientia* vel *reprimentia*). The most successful method of treating mucous and purulent inflammation of the conjunctiva is by the use of astringents, especially of nitrate of silver. This constitutes what is commonly termed the *stimulant* method of treatment. The astringents act first chemically, and then dynamically : the vessels and other tissues of the part are constringed, and their vital properties beneficially influenced. In erysipelas also, nitrate of silver is sometimes of considerable utility. In acute rheumatism and gout, the pain, redness, swelling, and stiffness of the affected joint are greatly relieved by the use of an iodine paint.

ORDER 3. ANTIDOTA.—Agents which alter the chemical nature of poisons, and either render them completely inert or greatly diminish their activity, are denominated *chemical antidotes* (αντίδοτα) or *counter-poisons*.

In the treatment of cases of poisoning, the therapeutical indications to be fulfilled are several :—

1. The most important is the removal of the poison from the part to which it has been applied. From the *stomach* it is removed by the stomach-pump, by the use of emetics, by tickling the throat with the finger or a feather dipped in oil, and, in the case of irritant poisons, by promoting vomiting, by diluents and demulcents. In corrosive poisoning (as by strong acids and alkalies), the use of the stomach-pump is dangerous. As house or domestic emetics, a dessertspoonful of flour of mustard, or a tablespoonful of common salt, stirred up in a tumblerful of water, or strong soap-suds, may be used. But the more effective emetics are one or two scruples of sulphate of zinc, or five to fifteen grains of sulphate of copper. In their absence, a scruple or half a drachm of powdered ipecacuanha, or even two or three grains of emetic tartar, may be administered. The emetic should be given in a glass of warm water, and repeated in a quarter of an hour if it have not operated. From the *bowels* the poison is best removed by the use of castor oil and laxative enemata.
2. Another indication in the treatment of poisoning is the use of the chemical neutralizers called *chemical antidotes*. These either render the poison insoluble, and thereby prevent its absorption, or convert it into a harmless soluble substance.
3. A third indication is to sheathe the living part from contact with the poison, by which not only the topical irritant action, but also the absorption, of the poison is prevented or lessened. This is effected by the agents which I have already noticed under the name of *mechanical antidotes* (see p. 158).
4. A fourth indication is to counteract or relieve the effects of the poison. This is effected by agents which may be conveniently termed *dynamical antidotes*. Thus coffee is given to counteract the narcotism produced by opium ; ammonia to relieve the depression caused by foxglove or prussic acid ; opium to allay the acute pain produced by irritant poisons, &c.
5. A fifth indication is to promote the speedy removal of the poison from the system after its absorption. Most poisons are absorbed into the blood, and are subsequently expelled from the system by the excreting organs (see pp. 105 and 106) ; but it is very doubtful whether we have any means of accelerating their elimination. Orfila[1] has recommended diuretics (white wine and water, Seltzer water, and nitrate of potash), as did, in

---

[1] *Traité de Toxicologie*, t. i. pp. 20 and 369, 4me édit. 1843.

ancient times, Celsus;[1] but this plan has completely failed in a case of poisoning by arsenic,[2] in which, as in many other instances, there was complete suppression of urine. In the case of arsenic, Flandin[3] thinks that the poison is eliminated by the mucous membrane of the alimentary canal; and he, therefore, suggests that, to prevent a second absorption, the use of purgatives and chemical antidotes should be continued for a longer period than usual, and, perhaps, to the end of the malady.

The following is a list of reputed antidotes :—

Metals.
- Iron filings.
- Zinc filings.

Acids.
- Tannic acid.
- Acetic or
- Citric acid.

Salts.
- Alkaline or earthy sulphates.
- Chloride of sodium.
- Hypochlorite of soda or of lime.

Alkalines.
- Ammonia.
- Carbonates of ammonia.
- Carbonates of soda.
- Magnesia.
- Carbonate of magnesia.
- Lime water.
- Chalk.
- Soap.

Sulphurets.
- Sulphuretted hydrogen (dissolved in water).
- Sulphuret of potassium.

Haloids.
- Chlorine.

Metallic oxides.
- Hydrated sesquioxide of iron.
- Mixed oxides of iron.

Organic substances.
- Albuminous substances (albumen, casein, and gluten).
- Starch.
- Oil.

- Animal charcoal.[4]

It has been well observed by Dr. Alfred Taylor,[5] that "objections might be taken to many of the substances contained in the list of antidotes: for the efficacy of some of them in neutralizing the effects of the poison is questionable."

The following is a table of poisons and reputed antidotes, with the forms in which the latter can be most readily obtained and employed :—

POISONS.	*Forms.*	ANTIDOTES.	*Form of Exhibition.*
Mineral acids	**Sulphuric** .... **Sulphate of indigo** .. **Nitric** .... **Muriatic** .... **Nitro-muriatic**	**Alkalines** .... **Fixed oils**	**Magnesia with milk.** **Chalk (or whitening) with milk.** **Soap suds.** **Diluted solution of carbonate of soda.** **Almond, olive, or lamp oil.**
Vegetable acids ..	**Oxalic** .... **Tartaric** .... **Sal acetosellæ (quadroxalate of potash).**	**Chalk**	**Chalk (or whitening) with water.**
Hydrocyanic acid	**Diluted hydrocyanic acid** .... **Cyanide of potassium** **Essential oil of almonds** .... **Bitter almond water** **Laurel water**	**Ammonia and its carbonate**	**Carbonate of ammonia and water to be swallowed.** **Diluted ammonia to the nostrils.** **Artificial respiration of air impregnated with the vapour of ammonia.**
		Mixed oxides of iron?	**Dissolve ten grains of sulphate of iron in one ounce of water, and add one drachm of tinct. sesquichloride of iron; to this solution add one scruple of carbonate of potass, previously dissolved in one or two ounces of water. Administer the mixture immediately.**
		Chlorine?	**A few drops of a solution of chlorine, or nitro-hydrochloric acid, mixed with water, to be introduced into the stomach.**

---

[1] *De Medicina*, lib. v. cap. 27.

[2] Flandin, *Traité des Poisons*, t. i. p. 331, Paris, 1846.

[3] *Op. cit.* pp. 585-6.

[4] The admission of charcoal among chemical antidotes may perhaps be objected to. But, as Dumas has observed (*Traité de Chimie*, t. i. p. 450), "the decolorizing property of charcoal is strongly influenced by, if indeed it ought not to be entirely attributed to, ordinary chemical forces;" and the antidotal property of charcoal seems referable to the same category as its decolorizing property.

[5] *On Poisons*, p. 85, 1848.

POISONS.	*Forms.*	ANTIDOTES.	*Form of Exhibition.*
Alkalies	Potash Soda Ammonia and their Carbonates	Acetic acid	Vinegar and water, p. æ. Water, acidulated with acetic or pyroligneous acid. Sour beer.
		or	
		Citric acid	Aqueous solutions of citric acid. Lemon, orange, or lime juice.
		Oil	Almond, olive, or lamp oil.
Earths	Caustic lime	Carbonic acid	Bottle of soda water,
Barytic salts	Chloride of barium (muriate of baryta) Nitrate of baryta Carbonate of baryta	Alkaline or earthy sulphates	Solution of sulphate of magnesia, or of sulphate of soda, or of alum. (For carbonate of baryta, a mixture of sulphate of magnesia and vinegar diluted—A. S. Taylor.)
Arsenic	Arsenious acid Arsenites Arsenic acid	Lime Water?	A mixture of oil and lime water, or milk and lime water.
		Hydrated magnesia?	Light magnesia mixed with water.
		Hydrated sesquioxide of iron?	Gelatinous hydrated sesquioxide of iron. A mixture of tinct. of sesquichloride of iron, or persulphate of iron, supersaturated by carbonate of ammonia. Ferri sesquioxydum (ferri carbonas) mixed with water.
		Animal charcoal	Purified animal charcoal. Common animal charcoal. Ivory black.
Antimony	Emetic tartar	Tannic acid	Solution of tannic acid. Astringent decoctions (as of tea, nutgalls, cinchona, oak-bark, pomegranate, tormentilla or uva ursi.) Astringent tinctures (as of cinchona, catechu, or kino) diluted with water. Astringent extracts dissolved in water.
	Sesquichloride or butter of antimony	Alkalines	See Mineral acids.
Mercury	Corrosive sublimate Nitrate of mercury	Albuminosa	White of egg diffused in water. Yolk of egg diffused in water. Milk. Wheat-flour mixed with water.
		Iron and zinc	A mixture of two parts of finely divided iron (filings) and one part of zinc.—(Bouchardat.)
Copper	Sulphate Verdigris	Albuminosa	See Mercury.
Zinc	Sulphate Acetate Chloride	Albuminosa	See Mercury.
		Alkalines	See Mineral acids.
Silver	Nitrate	Chloride of sodium	Common salt dissolved in water. Sea water.
		Albuminosa	See Mercury.
Lead	Oxides Carbonates Soluble salts	Alkaline or earthy sulphates	See Barytic salts. (For carbonate o lead, a mixture of sulphate of magnesia and vinegar diluted.—A. S. Taylor.)
		Hydrosulphurets	A solution of sulphuretted hydrogen, or Harrowgate water, to be drunk. Painters, workmen in lead factories, and others whose skin is impregnated with lead, should employ, as a sulphuretted bath, a solution of four ounces of sulphuret of potassium in thirty gallons of water.
Tin	Chloride (spirit of tin)	Albuminosa	See Mercury.
		Alkalines	See Mineral acids.
Iodine	Solid iodine Tincture of iodine	Starch	Decoction of starch (wheat-starch, arrow-root, or tapioca). Flour and water. Boiled potatoes. Bread.
Opium Vegetable alkaloids and their salts Vegetables whose active principles are alkaloids, as belladonna, hyoscyamus, stramonium, colchicum, veratrum, &c.		Tannic acid	See Emetic tartar.
		Animal charcoal	See Arsenic.
Sulphuretted hydrogen Hydrosulphuret of ammonia (sulphuret of ammonium) Sulphuret of potassium		Chlorine	Air slightly impregnated with chlorine to be inhaled.
		Hypochlorite of soda	Dilute solution of chloride [hypochlorite] of soda to be swallowed.
		Hypochlorite of lime	Dilute solution of chloride [hypochlorite] of lime to be swallowed.

ORDER 4. DISINFICIENTIA.—Chemical agents which absorb or destroy putrescent effluvia, organic fetors, and miasmata, are called *disinfectants* (from *dis*, signifying separation, and *infect*).

The following substances have been used as disinfectants :—

Chlorinium.
Acidum nitroso-nitricum.
Acidum sulphurosum.
Calx.
Sodæ hypochloris.
Calcis hypochloris.
Plumbi nitras.
Plumbi acetas.
Zinci chloridum.
Ferri acetas *vel* sesquichloridum.
Carbo animalis.
Carbo vegetabilis.

The constituents of animal and vegetable putrescent vapours have been thus arranged and distinguished by Dr. Leeson[1] :

Dangerous but inodorous.	*Odorous but slightly offensive.*	*Most offensive.*
Remittent miasmata.	Ammonia.	Sulphuretted hydrogen.
Typhoid miasmata.	Carburetted hydrogen.	Phosphuretted hydrogen.
Carbonic oxide.	Cyanogen.	Hydrosulphate of ammonia.
Carbonic acid.	Sulpho-cyanogen.	

These, however, are not the sole constituents of putrescent vapours; for many organic substances evolve, during putrefaction, odours not referable to any of the above-mentioned substances.

Disinfectants act more or less energetically on fetid and offensive effluvia, whose unpleasant odour they destroy: they are, therefore, *de-odorizers* (*nidorem purgantia* vel *tollentia*); and by analogy, they are presumed to act on and render inert miasmata; but their efficacy in this way is oftentimes very equivocal.

Charcoal absorbs putrescent effluvia. Lime absorbs carbonic acid, sulphuretted hydrogen, and perhaps, other noxious substances. It is extensively employed, in the form of lime-wash, for the walls of buildings. Chlorine acts on organic vapours and gases chiefly by its affinity for hydrogen, with which it unites and forms hydrochloric acid. It decomposes sulphuretted hydrogen, ammonia, hydrosulphuret of ammonia, phosphuretted hydrogen, and some other fetid and offensive vapours. It is used for fumigation (*fumigatio chlorinii oxymuriatica*, seu *Guytoniana*); but, in many instances, it has been found to be inert with respect to miasmata, while it is itself an irritating, offensive, and corrosive substance. The hypochlorites destroy offensive odours, decompose sulphuretted hydrogen, ammonia, and hydrosulphuret of ammonia. A solution of the hypochlorite of soda constitutes the disinfecting liquid of Labarraque (*liqueur de Labarraque*). Nitrous fumes act by their oxydising power. They are sometimes used for fumigation (*fumigatio nitrosa* seu *Smithiana*). Though they destroy many putrescent odours and decompose several of the gases evolved by putrefying animal matters, their corrosive and irritating qualities preclude their frequent employment. Several metallic salts are useful de-odorizers, and are termed disinfectants. They react on sulphuretted hydrogen and the hydrosulphurets, forming insoluble, inodorous, metallic sulphurets; and they unite with animal matters, and check putrefaction. They are, therefore, said to act as disinfectants *by fixation*. A solution of nitrate of lead (in the proportion of about one drachm of the salt to a fluidounce of water) constitutes *Ledoyen's disinfecting fluid*. The acetate or diacetate of lead may be employed as a substitute for the nitrate. A solution of chloride of zinc constitutes *Burnett's disinfecting liquid;* but its power of decomposing sulphuretted hydrogen is very limited. A solution of a persalt of iron is said to constitute *Ellerman's de-odorizing fluid.* A solution of sulphate of copper is applicable as a disinfectant. Sulphurous acid gas is a deoxidizing agent which destroys the colour and odour of many organic substances. It also has been used as a disinfectant. Besides the foregoing, other agents have also been employed as disinfectants. Thus the late Dr. Henry[1] has apparently shown, that infectious matter of certain diseaees (as scarlatina) is either dissipated or destroyed by a temperature not below 200° F.; and he, therefore, suggested that infected clothing, &c. may be disinfected on this principle; for he found that neither the texture nor colour of piece goods and other articles of clothing were injured by a temperature of 250° F.

---

[1] *Parliamentary Report*, in *Pharmaceutical Journal*, vol. vii. p. 113.

To disguise unpleasant odours, fumigations with balsamic and resinous substances (*e. g.* benzoin, styrax, olibanum, amber, mastic, &c.) camphor, cascarilla, &c. are sometimes employed (*fumigatio balsamica* seu *aromatica*). For this purpose *fumigating pastilles* are used. The fumes of burning lavender, brown paper, &c. are employed in the sick chamber for a similar purpose. None of these substances destroy noxious effluvia chemically: they merely overpower or disguise them. Ventilation is the most important disinfecting process.

ANTISEPTICA; *antiseptics* (from ἀντί, *against*; and σηπτικός, *putrefying*) or *antiputrescents.* These are substances which check or prevent putrefaction. Though really distinct in their object, they are often confounded with the disinfectants, because the same agents not unfrequently act both as antiseptics and disinfectants.

Putrefaction, properly so called, is a process peculiar to dead organic matter; and the agents, which check or prevent it, act physically or chemically. Warmth, air, and water, powerfully promote putrefaction; and their exclusion, therefore, is among the most effective antiseptic means. Thus cold, exclusion of atmospheric air, and desiccation, are good preservers of dead organic matters. A vacuum, gases which do not yield oxygen to organic matter, and coatings of oil, butter, tallow, wax, resin, and syrup, act by excluding air. Exposure to the temperature of boiling water has a remarkable influence in preventing fermentation and putrefaction; and on this, as well as on the exclusion of air, is founded Appert's method of preserving provisions.[2] Lastly, certain chemical agents, by contact with organic matter, check or prevent fermentation and putrefaction: these are the antiseptics properly so called, or *chemical antiseptics.*

The following is a list of the chemical antiseptics in most frequent use:—

Chlorinium.
Acidum nitrosum.
Acidum sulphuricum.
Acidum sulphurosum.
Acidum arseniosum.
Sodii chloridum.
Potassæ nitras.
Alumen.
Potassæ chromas.
Hydrargyri bichloridum.
Zinci chloridum.
Ferri sulphas.
Cupri sulphas.
Alcohol.
Spiritus pyroxilicus.
Creasoton.
Olea æetherea.
Olea empyreumatica.
Acidum tannicum.
Saccharum.

These antiseptics operate as such in different ways:—

---

[1] *Philosophical Magazine and Annals of Philosophy,* for January 1832, vol. xi. pp. 22 and 205.

[2] *The Art of Preserving all kinds of Animal and Vegetable Substances for several Years,* by M. Appert, translated from the French, 2d edit. Lond. 1812.

1. Some abstract water from the organic matter: as sugar.

2. Some act by forming with the organic matters compounds less susceptible of decay: as sulphuric acid, alum, arsenious acid, bichloride of mercury, chloride of zinc, sulphates of iron and copper, tannic acid, and creasote.

Alcohol, pyroxylic spirit, common salt, nitrate of potash, and some other substances, appear to act in a two-fold capacity: they both abstract water from and form chemical compounds with, the organic matter.

3. Some act as deoxidising agents; as sulphurous acid.

4. Some appear to act by their destructive influence on cryptogamic plants and infusory animals; as arsenious acid and bichloride of mercury (which also act chemically, as before mentioned). To these may probably be added the volatile and empyreumatic oils.

Antiseptics are of great service in the preservation of provisions and of anatomical preparations; but, as therapeutical agents, they are of little importance. They are sometimes employed to check the putrefaction of dead parts in gangrene, necrosis, and caries.

Besides the physical and chemical agents above mentioned, another class of substances has been termed antiseptics. Certain diseases, formerly denominated putrid, were supposed to depend on a putrescent or decomposed condition of the solids and fluids, characterised by the loose texture of the crassamentum, petechiæ, and an offensive condition of the excretions. Remedies which relieved this state were called antiseptics. Guersent denominates them *physiological antiseptics*.[1] But the alterations which are observed in the characters of the solids and of the blood in the above maladies have no apparent analogy with those which attend the putrefaction of dead animal matters; and accordingly modern pathologists have rejected the doctrine of putrescency of the fluids. Liebig[2] has endeavoured to revive the old notion; but, though his reasoning is ingenious, it is any thing but satisfactory.

Class III. *Topica Dynamica.* Topical Medicines acting Dynamically.

The dynamical agents used as topical remedies may be conveniently arranged in two sub-classes; the one including the *acrids*, the other the *emollients*. The former irritate or excite; the latter soothe and lessen excitement. A third sub-class, including those topical agents which diminish sensation, might be admitted; but they will be hereafter noticed in the class *neurotica*.

Sub-class 1. *Acria.* Acrids.

The substances called *acrids* stimulate, irritate, or inflame the living parts with which they are placed in contact, independently of any known chemical action. They are, therefore, irritants; and, to distinguish them from those which act chemically they may be denominated *dynamical irritants*.

The following is a list of the acrids most frequently employed in medicine as external topical agents:—

---

[1] *Dictionnaire de Médecine*, art. *Antiseptique*.

[2] *Organic Chemistry in its Application to Agriculture and Physiology*, edited by Lyon Playfair, Ph.D. London, 1840. Also, *Animal Chemistry*, edited by Dr. Wm. Gregory, 3d edit. 1846.

1. VEGETABLE.

CRUCIFERÆ.
Sinapis alba—*Seminum pulvis.*
Sinapis nigra—*Seminum pulvis.*
Cochlearia Armoracia—*Radix.*

TEREBINTHACEÆ.
Amyris elemifera—*Resina.*

COMPOSITÆ.
Anacyclus Pyrethrum—*Radix.*

SOLANEÆ.
Capsicum annuum—*Baccæ.*

THYMELACEÆ.
Daphne Mezereum—*Cortex.*

EUPHORBIACEÆ.
Euphorbia—? *Resina.*
Croton Tiglium—*Oleum.*
PIPERACEÆ.
Piper nigrum—*Baccæ.*
CONIFERÆ.
Pinus
Abies } *Terebinthina, oleum, terebinthinæ resina.*
Larix
SCITAMINEÆ.
Zingiber officinale—*Radix.*
LILIACEÆ.
Allium sativa—*Bulbus.*
Allium Cepa—*Bulbus.*

2. ANIMAL.

Cantharis vesicatoria.

3. INORGANIC.

Antimonii potassio-tartras.

The vegetable acrids were formerly supposed[1] to owe their activity to a peculiar proximate principle, which was denominated the *acrid principle of plants* (*principium acre plantarum*); but modern chemistry has shown that there is no one constituent of organic substances to which this term can be exclusively applied; but that many dissimilar principles agree in possessing acridity. Thus acrid substances are found among *acids* (*e. g.* gambogic), *vegetable alkalies* (*e. g.* veratria and emetina), *neutral crystalline matters* (*e. g.* elaterin), *volatile oils* (*e. g.* cantharidin, and the oils of mustard, garlic and rue), *resins* (*e. g.* the resins of euphorbium and mezereon), and *extractive matter* (*e. g.* colocynthin). The acrid matter of some plants (*e. g.* of ranunculus) has not yet been isolated. This probably arises from the facility with which it becomes decomposed.

The acrid principles in general readily become absorbed, circulate with the blood, and are thrown out of the system by the secreting organs. On both the vascular system and secreting organs they act as stimulants.

The acrids are employed as topical agents for various purposes :—

1. To stimulate or irritate the skin (*cutaneous stimulants*) for the purpose of effecting counter-irritation (see p. 128). When used to produce redness merely, they are termed *rubefacients* (*rubefacientia*). For this purpose mustard poultices are frequently applied externally to relieve internal inflammatory affections. Ginger, pepper, onions, garlic, and turpentine, are also employed for the same purpose. Sometimes they are used as *vesicants* or *epispastics* (*vesicantia* seu *epispastica*); that is, to cause the exhalation of a thin serous fluid under the cuticle. Cantharides are generally employed for this purpose: though mezereon, euphorbium, and some of the chemical irritants (as acetic acid and ammonia) are occasionally used for the same object. Lastly, some of the acrids produce a crop of pustules, when they are termed *suppurants* (*suppurantia*). Croton oil and emetic tartar are of this kind. The latter, perhaps, acts chemically as well as dynamically.

2. To stimulate ulcerated surfaces (*ulcer stimulants*). Surgeons employ

---

[1] See the *Principles of Modern Chemistry systematically arranged*, by Dr. F. C. Gren, translated from the German, vol. i. p. 428, Lond. 1800. Also Gura, *De Principio Plantarum acri*, Halæ, 1791.

a variety of topical applications to ulcerated surfaces for the purpose of augmenting or altering the vital activity of the part.

Sub-class 2. *Medicamenta Emollientia.* Emollients.

(Demulcents.)

Topical agents which diminish the tone or insensible contractility of the living tissues, and thereby cause relaxation and weakness, are denominated *emollients* (from *emollio,* I soften).

The following is a list of the most frequently employed emollients :—

1. VEGETABLE.

- Papaveraceæ.
  - Papaver somniferum—*Semina.*
- Lineæ.
  - Linum usitatissimum—*Semina, oleum.*
- Malvaceæ.
  - Malva sylvestris—*Herba.*
  - Althæa officinalis—*Radix, folia.*
- Leguminosæ.
  - Acacia vera—*Gummi arabicum.*
  - Astragalus—*Gummi tragacantha.*
  - Glycirrhiza glabra—*Radix, extractum.*
- Pomaceæ.
  - Cydonia vulgaris—*Semina.*
- Amygdaleæ.
  - Amygdalus communis—*Semina, oleum.*
- Compositæ.
  - Tussilago Farfara—*Folia.*
- Oleaceæ.
  - Olea europea—*Oleum.*
- Euphorbiaceæ.
  - Janipha Manihot—*Tapioca.*
- Artocarpeæ.
  - Ficus Carica—*Fructus.*
- Smilaceæ.
  - Smilax—*Radix sarzæ.*
- Palmaceæ.
  - Elais guineensis—*Oleum palmæ.*
  - Sagus Rumphii—*Sago.*
- Gramineæ.
  - Triticum vulgare—*Semina.*
  - Hordeum distichon—*Semina.*
  - Avena sativa—*Semina.*
  - Saccharum officinarum—*Saccharum.*
- Lichenes.
  - Cetraria islandica.

2. ANIMAL.

Lac.
Ichthyocolla.
Cornu cervi—*Gelatina.*
Mel.
Butyrum.
Axungia.
Adeps ovillus.
Cetaceum.
Cera.
Ovi albumen et vitellus.

3. INORGANIC.

Aqua tepida.
Vapor calidus.

Emollients have an operation diametrically opposite to tonics, especially to those which are astringent. They relax, soften, and swell the tissues, and render them more flexible. Applied to inflamed parts, they diminish heat, tension, and pain, and oftentimes assist in producing the resolution of the disease; and when the inflammation is too violent, or too far advanced, for this to be effected, they are useful by promoting suppuration (see pp. 14 and 22). They have a relaxing effect on the muscular fibre, and are, therefore, employed to relieve spasm. These effects have been referred by some to a physical, by others to a vital agency. During life the particles of the body are kept in approximation by two forces—attraction and the vital principle; and as emollients render the parts to which they are applied soft and flexible, that is, they produce relaxation, it becomes a question whether they operate by overcoming the cohesion of the molecules, or by modifying the vital properties. Most writers have regarded them as mechanical agents, and explain their influence just as they account for the action of warm water, or oil, on inorganic substances—leather, for example. But we should always be cautious in applying physical explanations to vital phenomena; and in the present instance this is particularly necessary. Emollients act physically on inorganised parts of the body (the cuticle, for example); but, on living parts, they exert another kind of influence; for cold water, which diminishes the cohesion of dead parts, and renders them softer and more flexible, has not the same effect on living tissues. Moreover, Dr. A. Crawford[1] has shown that some medicinal agents which diminish the cohesion of dead animal tissues have an opposite effect on the living ones.

The constitutional effects of emollients are for the most part those of nutrients, not of medicines; though the continued use of some is said to diminish the tone or vigour of the system generally; an effect ascribed by Barbier[2] to their absorption and local action on all the fibres of the body. This statement, however, is unsupported by fact in the case of gum, starch, sugar, gelatine, albumen, and some other principles.

Emollients are used to prevent the action of irritating matters on the body, by involving them, or by sheathing or defending surfaces from substances capable of operating on them injuriously. When used for these purposes, they are denominated *demulcents* (*demulcentia*, from *demulceo*, I mitigate or soften). Thus we administer them when acrid poisons have been swallowed. They are applied externally, in the form of local baths, poultices, fomentations, &c. both as emollients and demulcents, in local inflammations, painful ulcers, &c. In irritation, inflammation, and ulceration of the alimentary canal (as in gastritis, enteritis, diarrhœa, dysentery, &c.) they are taken either by the mouth or in the form of clyster. In catarrh, peripneumony, and pulmonic affections in general, where the cough is dry and harsh, and the expectorated matters are acrid, the use of emollients is often attended with very beneficial effects. By their lubricating and soothing influence over the nerves distributed to the fauces, they probably affect the bronchial membrane and pulmonic structure by a reflex action. In affections of the urinary passages, as ardor urinæ, aqueous drinks are very serviceable.

Water and *oily substances* are, perhaps, the essential emollient principles. For though *gum*, *starch*, *sugar*, *albumen*, and *gelatine*, are so termed, they do not act as such unless water be present. The properties of these principles will be described in other parts of this work.

Emollients may be arranged in the following orders :—

ORDER 1. AQUOSA. *Aqueous emollients.*—This order contains water, the principal and most important substance of the class. In order, however, that it may act as an emollient, it must have a certain temperature; for neither very cold nor boiling water has any emollient effect. Dr. Cullen fixes 62° F. as the lowest temperature at which this fluid can be emollient; and observes, that the greater its warmth the greater will be its emollient power, provided that pain or scalding be not produced. Aqueous vapour is, for two reasons, more emollient than liquid water: in the first place, it penetrates the organic tissues more powerfully; and secondly, a greater degree of heat can be applied by it than by liquid water. Dr. Cullen was doubtful whether advantage could be gained by any addition made to water.

ORDER 2. MUCILAGINOSA. *Mucilaginous emollients.*—This group has been subdivided into the pure mucilaginous emollients (as gum arabic, tragacanth, mallow, marsh mallow, &c.); the sweets (as figs); the bitters (as *cetraria islandica*, coltsfoot, and sarsaparilla); and the oily (as linseed, sweet almonds, poppy seeds, &c.)

ORDER 3. AMYLACEA. *Amylaceous emollients.*—This order includes starchy or farinaceous substances; as wheaten flour, oatmeal, barley, arrow-root, sago, tapioca, wheat starch, &c.

---

[1] *An Experimental Inquiry into the Effects of Tonics*, &c., 1816.

[2] *Traité Elémentaire de Matière Médicale*, t. ii. 2nde éd. Paris, 1824.

Order 4. Saccharina. *Saccharine emollients.*—This order consists of the saccharine substances; as ordinary sugar, honey, liquorice, &c.

Order 5. Oleosa. *Oleaginous emollients.*—This order includes the waxy, fatty, and oily substances; such as the animal fats, &c. (as lard, mutton suet, butter, wax, and spermaceti), and the vegetable oils (as olive, palm, linseed, &c.)

Order 6. Albuminosa. *Albuminous emollients.*—This includes the white and yolk of egg, and milk. Saliva and gastric juice are employed on the continent for medical purposes.

Order 7. Gelatinosa. *Gelatinous emollients.*—This order comprehends the gelatinous substances; as gelatine in its pure form, isinglass, hartshorn shavings, &c.

Class IV. *Hæmatica.* Medicines acting on the blood.

Medicines which are supposed to act as therapeutical agents by effecting changes in the condition of the blood are denominated *hæmatica* (αἱματικά, from αἷμα, *the blood*).

I have already had occasion to notice the alterations produced in the properties of the blood by medicines introduced into the circulation (see p. 111, *et seq.*) These are effected by a physical, a chemical, or a dynamical agency.

α. Medicines acting Physically on the Blood.

Under this head I shall notice those agents which alter the specific gravity of the plasma.

Order 1. Diluentia. *Diluents.*—These are agents which lower the specific gravity of the plasma by increasing the proportion of its fluid parts.

Aqua. | Aquosa blanda.

Aqueous fluids can alone act as diluents: their effect being in reality due to the water which they contain.

The rapid introduction of water into the circulation, either by injection into the veins or by absorption from the alimentary canal, lowers the specific gravity of the plasma, checks absorption (see p. 107 and 136), and promotes the action of the secreting and exhaling organs (kidneys, skin, and pulmonary surface).

A diminution in the specific gravity of the plasma is attended with an important endosmotic effect; namely, enlargement or distension of the blood-corpuscles (see pp. 95, 96, and 112). This fact was first noticed by Hewson.[1]

The thirst and desire for aqueous fluids evinced by patients labouring under fever are well known. Are these phenomena connected with the altered condition of the blood (*hypinosis sanguinis*, Simon[2])? Under the various names of slops, ptisans, thin diet, fever diet, broth diet, &c. diluents are employed in fevers to quench thirst and promote the action of the secreting and exhaling organs; while the small quantity of nutriment contained in some of them contributes to the support of the system.

---

[1] *The Works of Wm. Hewson, F.R.S.*, edited by G. Gulliver, p. xlvi. Lond. 1846.

[2] Simon's *Animal Chemistry*, translated by Dr. Day, vol. i. p. 287. *Hypinosis*, from ὑπό, *under*; and ἶς, ἰνός, *the fibrin of blood.* In this condition of blood, the quantity of fibrin is frequently less than in health, while the quantity of corpuscles is either absolutely or relatively increased; and the quantity of solid constituents is also frequently larger than in the normal fluid. Moreover, in the contagious fevers, the blood is probably the seat of a morbid poison.

ORDER 2. INSPISSANTIA. *Inspissants.*—These are agents which augment the specific gravity of the plasma.

There are two modes of increasing the density of the plasma: the one is by withholding or diminishing the use of alimentary fluids; and the other is by the employment of evacuants (hydragogues, diuretics, and diaphoretics), which carry off part of the watery portion of the blood.

Restriction in the amount of fluids taken, or, in other words, the use of a *dry diet*, is practised in the following cases:—

α. When our object is to lessen the volume of the circulating fluid; as in valvular diseases of the heart.

β. When we desire to promote the coagulation of the blood. Thus, in aneurism of the aorta, and other large vessels, our hope of cure depends on the coagulation and deposition of the fibrin of the blood within the aneurismal sac. In such cases we endeavour to increase the specific gravity of the plasma.

γ. When we are desirous of repressing excessive secretion. Thus, in hydruria and diabetes, an important part of the treatment consists in the restriction of the use of drinks. So also in coryza, and probably other catarrhal affections, total abstinence from liquids (constituting the *dry treatment*) for a couple of days is an effectual, though not very agreeable, method of cure.[1]

By the use of evacuants (such as hydragogues, diuretics, and diaphoretics), a discharge of the watery part of the blood is effected, and the density of the plasma thereby increased. In consequence of this, and by an action of exosmose, the blood-corpuscles are emptied of part of their contents, and become in consequence somewhat collapsed and shrivelled.[2] In diseases characterised by excess of water in the blood (*spanæmi*, Simon[3]), as anæmia, as well also in the morbus Brightii, the employment of purgatives to carry off water from the blood constitutes an important part of the treatment.

The injection into the blood of saline solutions having a specific gravity greater than that of the serum (1·027 or 1·028) causes shrivelling or collapse of the corpuscles. This fact was first ascertained by Hewson.

β. Medicines acting Chemically on the Blood.

A considerable number of medicines produce a more or less transitory chemical change in the blood.

Some of them diminish the amount of the solid constituents (especially the fibrin and corpuscles) of the blood, and thus give rise to that condition of the circulating fluid called by Simon spanæmia, or poverty of the blood; others augment the number of blood-corpuscles or the amount of hæmatin in the blood. The former may be conveniently termed *spanæmica;* the latter, *hæmatinica*.

ORDER 3. SPANÆMICA (*σπαναιμικά*, from *σπανός*, *poor;* and *αἷμα*, *blood: antiplastic alteratives* or *dysplastica*, Oesterlen: *plastilytica* and *erethi-*

---

[1] Dr. C. J. B. Williams, *Cyclopædia of Practical Medicine*, art. *Coryza;* also, *London Medical Gazette*, vol. xxi. p. 676, for Jan. 27, 1838.

[2] See *ante*, p. 96. Also, Dr. Rees, in *Lond. Med. Gaz.* vol. xxxv. p. 849, April 4, 1845.

[3] *Animal Chemistry*, vol. i. p. 306.

lytica (*hæmatolytica*, Schultz: *dyscrasiaca*). Spanæmics are agents which, by long-continued use, impoverish the blood.

This order includes iodine and bromine, most of the metals (not iron), the acids (commonly so called), the alkalines, and the alkaline and earthy salts.

They act topically as chemical irritants. They become absorbed, and are afterwards readily detected in the excretions. Their long-continued use in moderate doses injures digestion, assimilation. and sanguification; and gives rise to a state of dyscrasy or cachexia. Their effects in many cases *accumulate;* and hence arise the phenomena of *saturation* (see *Lead* and *Mercury*). In excessive doses they act as caustic and irritant poisons.

They are important therapeutic agents, and serve numerous useful purposes in medicine. But, these being very varied, and their therapeutic properties in some cases opposed (*e. g.* the acids and alkalies), I shall reserve my notice of their remedial uses to the subdivisions of the order. As topical remedies, they have already been spoken of (see *Topica Chemica*).

The spanæmics may be conveniently arranged in four sub-orders: one, including the mineral and vegetable acids, which quench thirst and lessen preternatural heat (*sp. adipsa et refrigerantia*;) a second, comprehending the alkalines, iodine, bromine, sulphur, the salts, mercurials, and antimonials, which act as resolvents and liquefacients (*sp. resolventia* seu *liquefacientia*); a third, containing the preparations of arsenic, copper, zinc, silver, and bismuth, which are employed in the treatment of certain morbid affections of the nervous system of a spasmodic nature (*sp. antispasmodica*); and the fourth, consisting of the preparations of lead, employed for their astringent and sedative properties, and which, in poisonous doses, excite palsy (*sp. saturnina*).

SUB-ORDER *a.* SPANÆMICA ADIPSA ET REFRIGERANTIA (*hæmatolytica physoda*, Schultz; *acida*; *antalkalina*).—The thirst-quenching, refrigerant spanæmics. This sub-order includes both mineral and vegetable acids.

Acida mineralia.	*Acida vegetabilia.*
Acidum sulphuricum.	Acidum aceticum.
Acidum nitricum.	Acidum citricum.
Acidum hydrochloricum.	Acidum tartaricum.
Acidum phosphoricum.	

The chemical action of the mineral acids, as well as of acetic acid, on the tissues and albumen, has already been noticed (see pp. 92 and 97). In the concentrated state they destroy both organisation and life (morpholysis and biolysis, see p. 98), and are employed as escharotics (see p. 161). The diluted acids coagulate the liquid portion of the mucus of the mucous membranes. Dilute acetic, oxalic, and tartaric acids (but not the dilute mineral acids), dissolve the capsule of the mucous corpuscles. The concentrated acids dissolve the epithelium scales; but the dilute acids do not affect them.

When sufficiently diluted, they cease to be corrosive, though they still exert a chemical influence. Thus, when applied to the skin, they harden the cuticle by uniting with its albumen; and, when applied to the mucous surfaces, they produce astriction and a slight whitening of the part (from their chemical influence on the mucus and the epithelial coat).

The diluted mineral and vegetable acids, when swallowed in moderate doses, at first allay thirst, sharpen the appetite, and promote digestion. They check preternatural heat, reduce the frequency and force of the pulse, lessen cutaneous perspiration, allay the troublesome itching of prurigo, sometimes prove diuretic, and occasionally render the urine unusually acid. Under their use, the milk often acquires a griping quality, and the bowels become slightly relaxed. By their long-continued employment, the tongue becomes coated with a whitish but moist fur, the appetite and digestion are impaired; while griping and relaxation of bowels, with febrile disorder, frequently occur. If their use be still persevered in, they more deeply injure the assimilative processes, and a kind of scorbutic cachexy is established.

The concentrated mineral acids act as corrosive poisons, and destroy both the organisation and life of the parts with which they come in contact (see p. 98). They depress the heart's action through the agency of the nervous system, and on the principle of shock (see p. 118).

The chemical influence of the acids in the alimencary canal is an interesting object of inquiry. Their relations to the organised tissues, albuminous liquids, and mucus, have been already alluded to. Small quantities of the dilute acids do not appear to injure the digestive powers of the gastric juice, which, in its normal state, possesses acid properties. Indeed, it is well known that, in the preparation of an artificial digestive liquor, the presence of minute portions of a free acid (hydrochloric or acetic) is necessary. It is obvious, however, that if, as Liebig[1] infers from Lehmann's experiments, the gastric juice naturally contain lactate of magnesia, this salt will suffer partial decomposition by the introduction of one of the mineral acids into the stomach. The acids unite in the alimentary canal not only with the albuminous substances and mucus, but also with the alkaline (soda) and earthy bases (lime and magnesia) found in the saliva, bile, and pancreatic juice; and in this way they become neutralized and form compounds, some of which are soluble, others insoluble: the former are absorbed, and the latter rejected.

In considering the chemical influence of the acids on the blood and on distant parts, it is important to bear in mind the fact just mentioned; namely, that the acids[2] enter the blood in combination with bases; so that they react in the stomach and alimentary canal as acids, but in the blood as salts. The impossibility of dissolving ossific deposits in distant organs by the internal administration of the acids is, therefore, readily accounted for. It is obvious, moreover, that no analogy can exist between the chemical influence of free acids added to blood after its withdrawal from the body, and that of acids, combined with bases (that is, of salts,) entering the blood from the alimentary canal.

That the acids which have been administered by the mouth traverse the system, is demonstrated by the fact of their subsequent detection in the secretions, especially the urine (see pp. 90 and 105). But, while in the blood, they must be in combination, since their acid properties are neutralized.

It must not, however, be inferred that the influence of the acids on the blood and general system is identical with that of the salts of the same acids;

---

[1] *Researches on the Chemistry of Food*, edited by Dr. Gregory, p. 138, Lond. 1847.

[2] Hydrocyanic acid may possibly be an exception to this statement, since its odour has been detected in distant parts. The same, perhaps, may be the case with some other weak acids, as carbonic acid. Liebig (*Researches on the Chemistry of Food*, 1847) ascribes the alkaline reaction of the blood, as well as the power of this fluid to take up carbonic acid, to the presence of phosphate of soda (PO^5, $2NaO$, HO).

for it must be remembered that the acids deprive the system of part of its alkaline and earthy bases, which are employed in neutralizing and conducting the acids safely out of the system, and which, but for the administration of the latter, would have been otherwise applied to the purposes of the economy. Now these bases, though obtained directly from the saliva, the bile (chiefly), and the pancreatic juice, are indirectly derived from the blood; so that, in a secondary way at least, the acids must modify the composition of the blood.

A striking illustration of the different effects produced on the system by the vegetable acids and by their salts is derived from Wöhler's observations before noticed (p. 105). Several of the free vegetable acids, when administered by the mouth, are subsequently detected in the urine in combination with an alkali; but, when given in combination with an alkali, carbonates (bicarbonates?) of the alkali are detected in the urine. The free vegetable acid, therefore, robs the system of alkaline matter, while the salts of the same acids deprive the system of oxygen. Benzoic acid ($C^{14}H^5O^3$), during its passage through the system, also abstracts the elements of glycocoll or gelatine sugar ($C^4NH^4O^3$); for it appears in the urine in the form of hippuric acid ($C^{18}NH^9O^6$) combined with a base.

From the preceding remarks, it may be inferred that the precise changes effected in the blood by the internal administration of the acids are very obscure; nay, the very action of these bodies on the circulating fluid is rather assumed than demonstrated. The statements of authors as to the changes in the physical and chemical properties of the blood, produced by the administration of acids, are, therefore, for the most part, hypothetical, as are also the pathological and therapeutical deductions therefrom. Several of them, indeed, are founded on erroneous premises. Thus, Dr. Stevens[1] states that, "when acids are used internally, some of them enter the circulation, darken the colour of the current, and reduce the force of the vascular organs; or when we add a weak acid solution to healthy blood out of the body, we make it quite as black as it is either in scurvy, cholera, or the last stage of the climate fever." Now it is obvious that Dr. Stevens' statements, respecting the effect on the blood of acids administered internally, are entirely hypothetical, and are founded on the erroneous notion that the acids enter the circulation in the free state, and that their action on the circulating blood is similar to that which they exercise on blood drawn from the body. Both of these errors I have already exposed (see p. 175). Schultz,[2] also, has more recently fallen into similar errors. Both the acids and salts (alkaline and earthy), he says, act on the blood as biolytic[3] agents; and he, therefore, terms them hæmatolytics (*hæmatolytica*): the former, however, act on the corpuscles, and are, in consequence, called *blood-corpuscle hæmatolytics* (*hæmatolytica physoda*); while the latter exert their influence on the plasma, and are, therefore, denominated *plasma hæmatolytics* (*hæmatolytica plasmatoda*). To the action of the acids on the blood-corpuscles he ascribes their antiphlogistic power. They have, he says, an extraordinary faculty of abstracting the colouring matter from the corpuscles, and of rendering it soluble in the plasma. When thus decolorised, the corpuscles possess a very inconsiderable respiratory power; and the more they are decolorized by the use of acids and acid drinks, the weaker is the pulmonary respiration; and therefore, after the use of acid medicines, vital excitation and calorification are lessened. Hence the reputed cooling effects of acids. The blood, therefore, continues Schultz, always becomes black after its intermixture with acids, as well as by their use.

---

[1] *Observations on the Healthy and Diseased Properties of the Blood*, p. 263, 1832.

[2] *Naturliches System der allgemeinen Pharmakologie*, pp. 156 and 444, 1846.

[3] I have before (p. 98) explained the meaning of the word biolytic.

The acids are thrown out of the blood by the kidneys. They probably never pass off in the free state, but always in combination with a base; and hence they do not in general increase the acidity of the urine.[1] But, even in those cases in which the urine has become preternaturally acid after the use of acid medicines, it is probable that the augmented acidity was dependent on an increase in the proportion of those ingredients which, in the healthy state, render the urine slightly acid.[2] Perhaps, therefore, in the cases now alluded to, the acids acted upon the digestive and assimilating organs, and indirectly modified the renal secretion;[3] or appropriated to themselves bases which, but for their presence, would have been eliminated in combination with the normal constituents of the urine.

A recent eminent writer[4] states, that the urine may be easily rendered acid "by any vegetable acid,—as tartaric, citric, acetic acids;" and he quotes, apparently as his authority for this assumption, Wöhler's experiments.[5] The affinity of the vegetable acids for bases being weaker than that of the mineral acids, the presence of the former in the urine, in a free state or as super-salts, appears *à priori* less improbable.[6] But it is more likely that the vegetable, as well as the mineral, acids acidify the urine by acting indirectly; namely, on the digestive and assimilating organs. As the vegetable acids, when swallowed in combination with alkalies, undergo oxidation in the system, it might be expected that the free vegetable acids would be subject to a similar change; but such does not appear to be the case; why, it is not easy to say.

---

[1] Berzelius (*Traité de Chimie*, t. vii. p. 401, 1833,) observes that the mineral acids never increase the acidity of the urine. Wöhler (Tiedemann's *Zeitschrift für Physiologie*, Bd. i. S. 138,) states that the urine of a dog, to which two drachms of oxalic acid had been given fasting, was not preternaturally acid, though it contained a soluble oxalate, and deposited small crystals of oxalate of lime. Practical physicians and surgeons are familiar with the fact of the difficulty, and, in many cases, impracticability of acidifying alkaline urine. (See, on this subject, Dr. Golding Bird's observations in the *London Medical Gazette*, Jan. 22d, 1847, p. 154). Orfila (*Journal de Chimie Médic.* t. viii. 11e Sér. p. 266, *et. seq.*) detected nitric, sulphuric, hydrochloric, oxalic, and perhaps acetic, acids in the urine of dogs poisoned by these substances; but in no case does it appear that these acids were in the free state.

[2] Mr. Brande (*Phil. Trans.* for 1813,) states, that when the mineral acids are given to relieve phosphatic deposits, they are apt to induce red gravel (uric acid).

[3] Berzelius (*op. cit.* p. 414) gave to a patient affected with alkaline urine, with phosphatic deposits, increasing doses of phosphoric acid without being able to acidify the urine. Ultimately the acid purged the patient, and then the urine acquired an acid character, recovered its transparency, and deposited uric acid.

[4] Dr. H. Bence Jones, *On Gravel, Calculus, and Gout*, p. 86, Lond. 1842.

[5] Wöhler's statements do not bear the construction which has been put on them. This eminent chemist experimented with oxalic, tartaric, citric, malic, gallic, succinic, and benzoic acids. In one case only (viz. in the experiment with tartaric acid), he observes that "the urine appeared unusually acid." In the case of oxalic acid, he says, it was not more acid than usual; and, in that of succinic acid, he found it to be alkaline. The acidity or alkalinity of the urine is not stated in the cases of citric, malic, and gallic acids; though he observes that the odour, taste, and proportion of phosphate of lime of the urine appeared to him to be natural in the animals to whom citric and malic acids had been given. With respect to the benzoic acid, he observes that it was found in the urine in combination with a base. In a subsequent part of his paper (p. 307), he concludes that, "from the foregoing experiments with oxalic, tartaric, and benzoic acids, it is probable that these—and perhaps all acids—are never eliminated in the urine in the free state, but always in combination with a base."

[6] Mr. Brande (*Phil. Trans.* 1813), says that the vegetable acids are less apt to cause the deposition of red gravel (uric acid) in the urine than the mineral ones.

As the acids become neutralized by combination with bases before their absorption into the blood, it follows that, as free acids, they operate topically only. They are useful as such for the following purposes:—

1. As escharotics (see p. 161).

2. As antalkalines in poisoning by the alkalies and their carbonates (see p. 165), and in some forms of pyrosis which are attended with an alkaline condition of the gastric secretion.[1]

3. As astringents and styptics in hemorrhage from the stomach and bowels. They constringe the blood-vessels of the mucous membrane of the alimentary canal, and coagulate mucus and blood.

4. As lithontriptics. Very dilute solutions of the mineral acids (hydrochloric and nitric) have been injected into the bladder as solvents for phosphatic calculi. They have proved useful in chronic inflammation of the mucous membrane of the bladder, accompanied by a deposition of the phosphates. They are serviceable in two ways,—by their solvent action on the concretions, which they assist in disintegrating; and by benefiting the condition of the mucous membrane of the bladder.[2]

The acids are also efficacious, as remote or general agents, in several cases in which their chemical influence is not very obvious. Thus they are used,—

5. To check profuse sweating in hectic fever.

6. To allay the distressing itching and irritation of the skin in prurigo and lichen.

7. To lessen preternatural heat and reduce the frequency and force of the pulse; as in febrile complaints and hemorrhages (pulmonary, uterine, &c.)

8. To relieve narcotism after the poison has been evacuated from the stomach and bowels.

9. In dyscrasies or diseases which have been supposed to depend on, or be connected with, a depraved condition of the animal fluids; as scorbutus, secondary syphilis, and mercurial cachexia.

The efficacy of vegetable acids (especially citric acid) and fresh vegetables and fruits in the treatment of scurvy is too well established by experience[3] to be affected by the hypothetical objections of Dr. Stevens[4] to the use of acids in this malady. A satisfactory explanation of their *methodus medendi* is still wanting; for though the assumption that non-nitrogenous food in scurvy is useful by acting, in the oxidizing processes of the system, as a substitute for the animal tissues which are thereby preserved, accounts for the fact[5], that the pure acids are less efficacious than acid vegetable juices,[6] yet it fails to account for various circumstances (such as the inefficacy of the fatty substances, and the occasional failure of even lemon-juice to prevent or to check scurvy),[7] and, therefore, cannot be considered as a satisfactory explanation.

10. In the so-called putrid fevers, the mineral acids have frequently proved

---

[1] Dr. R. D. Thomson, *British Annals of Medicine*, March 31, 1837.

[2] Sir B. Brodie, in the *Lond. Med. Gazette*, vol. viii. p. 355, 1831; Dr. Golding Bird, *Urinary Deposits*, p. 209.

[3] See Dr. Lind's *Treatise on the Scurvy*, 3d edit. Lond. 1772.

[4] *Observations on the Healthy and Diseased Properties of the Blood*, pp. 263 and 264, Lond. 1833.

[5] Dr. Budd, *Lectures on the Disorders resulting from Defective Nutriment*, in the *London Medical Gazette*, July 1842, p. 716.

[6] The acid vegetable juices contain acidulous alkaline salts, which, as before stated, suffer oxidation in the system, though the free acids do not.

[7] See my *Treatise on Food and Diet*, pp. 147 and 358.

serviceable. They were originally employed under the idea that they checked the supposed putrescent tendency of the fluids. May they not be useful by abstracting from the system basic matter?

11. In phosphatic deposits in the urine, the acids, both mineral and vegetable, are often resorted to, and occasionally with relief. They are, however, very uncertain, and, at best, are but palliative.

12. As tonics, the diluted mineral acids (especially the sulphuric) are frequently employed in conjunction with the vegetable bitters; as cinchona and quina.

SUB-ORDER β. SPANÆMICA RESOLVENTIA SEU LIQUEFACIENTIA.—Resolvent or liquefacient spanæmics. This sub-order includes the agents which, in the 2nd edition of this work (vol. i. p. 194), were denominated simply *liquefacientia*.

This sub-order includes the ***alkalines, iodine, bromine, sulphur, mercurials***, and ***antimonials***.

These spanæmics promote secretion and exhalation generally, soften and loosen textures, check phlegmonous inflammation, lessen inflammatory effusions, and promote their re-absorption. Their antiphlogistic effect is best seen after the use of mercury, the action of which, observes Dr. Farre,[1] "is positively antiphlegmonous. If it be pushed far enough, it produces an effect the exact reverse of the phlegmonous state; namely, the erythematous inflammation, the tendency of which is to loosen structure, while that of phlegmonous inflammation is to bind texture."[2] Under the influence of mercurials, the gums become spongy, the intestines and pulmonic membranes softened,[3] and deposits of coagulable lymph (as in iritis) are removed. The beneficial effects of mercurials, antimonials, iodine, alkalies,[4] &c. in promoting the resolution of visceral and glandular inflammation, and in relieving active congestion, may be ascribed to the antiphlegmonous action referred to by Dr. Farre. These agents are opposed to the exudation of plastic or coagulable lymph (hence they check union by adhesion), and to the formation of false membranes. During their use, visceral and glandular enlargements and indurations, thickening of membranes (as of the periosteum), and morbid, but non-malignant, growths of various kinds, are sometimes observed to get softer and smaller, and ultimately to disappear. Dr. Ashwell[5] graphically describes indurations and hard tumors of the uterus as having "melted away" under the influence of iodine. In hepatization of the lungs, the effused solid matter is often absorbed, and the cells rendered again permeable to air, by the use of mercury. It is on account of the influence of liquefacients in checking phlegmonous inflammation, obviating its consequences, and promoting the removal of enlargements, indurations, &c. that they are frequently denominated ***resolvents*** (from *resolvo*, I loosen or dissolve).

The resolvent operation of these medicines is usually explained by referring it to an augmented activity of the absorbents. But this explanation is imperfect, and does not account for all the phenomena. The effect is ascribable to a change in the nutrition of the parts affected. My friend, Dr. Billing,[1] is of opinion that "mercury and iodine remove morbid growths by starving them, which they effect by contracting the capillaries." But I conceive there must be something more in the influence of these remedies than a mere reduction in the quantity of blood supplied to the affected parts. The enlargements which these agents remove are not mere hypertrophies; their structure is morbid, and they must, in consequence, have been induced by a change in the quality of the vital activity; in other words, by morbid action. Medicines, therefore, which remove these abnormal conditions, can only do so by restoring healthy action; that is, by an alterative influence. By what force or power they are enabled to effect changes of this kind must, for the present at least, be a matter of speculation. Müller[2] thinks it is by affinity. "They produce," he observes, "such an alteration in the composition of the tissues, that the affinities already existing are annulled, and new ones induced, so as to enable the vital principle—the power which determines the constant reproduction of all parts in conformity with the original type of the individual—to effect the further restoration and cure; the mercury itself does not complete the cure."

---

[1] *Essays on the most important Diseases of Women*, by Robert Ferguson, M.D. Part i. p. 215, Lond. 1839.

[2] This statement of Dr. Farre must be received with some limitation; for, as Dr. C. B. Williams (*Principles of Medicine*, p. 280) has observed, "lymph is thrown out, and granulations form, and healthy ulcers heal, during mercurial action."

[3] Ferguson's *Essays*, p. 216.

[4] Mascagni, in the *Memorie della Società Italiana della Scienza*, Modena, 1804. Also, Nigri, in *Lond. Medical Gazette*, vol. xiv. p. 713.

[5] *Guy's Hospital Reports*, No. 1, 1836.

May not these remedies act by correcting the quality of the blood in inflammation? It is now well known that the blood in this disease contains an abnormal quantity of fibrin, the quantity of which is diminished by the use of the liquefacient spanæmics. Moreover, in buffy blood, the red corpuscles sink more rapidly than in healthy blood; a circumstance which Mr. Gulliver ascribes to their increased tendency to cluster or aggregate. Now, the salts tend to keep the corpuscles asunder; and to this cause Mr. Gulliver ascribes the efficacy of these agents in inflammation.[3] Furthermore, the blood of an inflamed part contains an increased number of white globules, which have a remarkable disposition to adhere to the walls of the vessels and to one another;[4] and it is not improbable that the beneficial effects of resolvents and liquefacients may be due to their influence in diminishing the number and adhesiveness of these globules.

1. *Alkalina. Alkalines* (*antacida; absorbentia*).—This division includes the alkalies, the alkaline earths, and the carbonates of these substances.

Potassa.
Soda.
Ammonia.
Calx.
Magnesia.

Potassæ carbonas.
Potassæ bicarbonas.
Sodæ carbonas.
Sodæ bicarbonas.

Ammoniæ carbonas.
Ammoniæ sesquicarbonas.
Calcis carbonas (*creta*).
Magnesiæ carbonas.
Magnesiæ bicarbonas.

The chemical action of the alkalies on the tissues has been already alluded to (see pp. 93 and 97).

They dissolve albuminous substances and mucus, and saponify fatty substances. Hence, in the concentrated state, they destroy both organization and life (see p. 98); and, when swallowed in this form, act as corrosive poisons. From their solvent action on the organic tissues, they have a softening influence even in the dilute form, and, in consequence, are saponaceous to the touch.

---

[1] *First Principles of Medicine*, pp. 69, 70, 4th edit. Lond. 1841.

[2] *Physiology*, by Baly, vol. i. p. 363.

[3] *The Works of William Hewson*. F.R.S. edited, with an Introduction and Notes, by G. Gulliver, F.R.S. pp. 40 and 231 (footnotes), Lond. 1846.

[4] Dr. C. J. B. Williams, *Principles of Medicine*, p. 209, *et seq*. Lond. 1843.

When swallowed in the diluted state, they destroy the acidity of the stomach, by combining with, and thereby neutralizing, the free acids contained in this viscus. The salts thus formed are, for the most part at least, absorbed. Any excess of alkali present probably becomes absorbed in combination with albuminous matter.

They probably aid in the digestion and absorption of fatty substances, especially when there is a deficiency of bile and pancreatic juice.[1]

In small or moderate doses they promote secretion from the gastro-intestinal mucous membrane, become absorbed, act as diuretics, and communicate an alkaline quality to the urine.[2]

By repeated use, in full doses, they produce the general effects of liquefacients, already noticed (see p. 179).

Their long-continued employment disorders the functions of the digestive and assimilative organs, and gives rise to a kind of dyscrasia analogous to scurvy. The blood becomes deteriorated or spanæmic, coagulates imperfectly when drawn from a vein, and the nutrition of the body generally is impaired.[3]

The carbonates of the alkalies act less energetically on the tissues, as chemical agents, than the caustic alkalies; the bicarbonates less than the monocarbonates.

---

[1] See the experiments of Matteucci on the use of the alkali of the bile and pancreatic juice in aiding the absorption of fatty substances by forming an emulsion with them. (*Lectures on the Physical Phenomena of Living Beings*, pp. 110—113, Lond. 1847.)

[2] That the urine becomes alkaline from the employment of the alkalies and their carbonates, is a fact to which I and most practical physicians can bear testimony; but it may not be amiss to refer to some published authorities on this point. Mascagni (quoted by Wöhler) found the urine alkaline from the use of one drachm of carbonate of potash daily. Mr. Brande (*Phil Trans.* for 1810) observed the alkalinity of the urine after the employment of the carbonates of soda and potash. He says, that two drachms of carbonate of soda rendered the urine alkaline in six minutes, and produced the full effect in a quarter of an hour, occasioning a precipitation of the phosphates of lime and magnesia, and restoring the blue colour to reddened litmus paper. Magnesia had the same effect of occasioning a precipitation of the phosphates; but, on account of its insolubility, required a greater time to produce the effect. Lime-water required five hours to produce a sensible precipitation, which, even then, was not nearly so distinct as from the alkalies. Dr. Bostock (*Medico-Chirurg. Trans.* vol. v. p. 80), found that the urine became alkaline and effervesced with acids after the use of two ounces and a half of carbonate of soda daily.

[3] "Not a few of those who took the alcalious saponaceous hotch-potch of Mrs. Stephens, and the soap-lees, for a long time together, fell into hectical heats, a hot scurvy, hæmorrhages, dysentery, &c. A remarkable instance of this lately happened to a gentleman of the West of Cornwall, who, for several years, had laboured under a stone in his bladder. He was originally of a tender constitution; and had taken the lixivium, &c. for several weeks, till at length his gums began to grow exceedingly spongy, inflamed, and livid—at last extremely sore and putrid; insomuch, that the flesh might be pulled off with the greatest ease: they bled considerably on the least pressure; and a thin bloody ichor continually leaked off from them. Livid spots also appeared on him; and his legs, and thighs especially, became vastly sore, and of a claret colour, or rather more livid, so that a mortification was feared. Upon this I was consulted for him by Mr. Hingston, a very skilful apothecary of Penzance, who stated his case. Apprehending an alkalescent putrid state of the humours, and a dissolution of the blood from the course he had gone through and the symptoms he now laboured under, I advised the decoction and extract of the bark with elixir vitrioli, and subacid drinks and diet, which soon took off the inflammation, sponginess, and bleeding of his gums, and prevented the further advance of the livid colour of his thighs, &c. which, in a few days, disappeared. About some two or three weeks after, a copious eruption of red fiery pustules broke out upon him, which seemed to promise some advantage. However, being reduced exceedingly weak by a complication of disorders and a confirmed hectic, he died quite tabid about a fortnight or three weeks after. A very large stone was taken out of his bladder after his death." (Huxham's *Essay on Fevers*, p. 48, 3d edit. Lond. 1747).—See also the article *Ammoniæ sesquicarbonas* for an account of a case illustrating the ill effects arising from the long-continued use of large doses of this alkaline substance.

The alkaline earths (magnesia and lime) are much less energetic, especially magnesia, in their chemical action on the tissues than the alkalies; and their carbonates (especially carbonate of lime) exert scarcely any chemical influence over the albuminous tissues.

The alkalines are employed therapeutically for the following purposes:—

1. As escharotics (see p. 161).

2. As antacids or absorbents in poisoning by the acids (see p. 164), and in dyspepsia with acidity of the stomach. In the latter case, they may perhaps be serviceable in promoting the digestion of the fatty substances, where there is a deficient secretion of bile (see p. 181).

3. As softeners and cleansers of the skin, weak alkaline solutions are used as cosmetics. They exercise a solvent action on the cuticle.

4. As lithontriptics or antilithics they will be noticed hereafter (see *Lithontriptica*).

5. As diuretics they will be noticed on a future occasion (see *Diuretica*).

6. As antiplastics and resolvents in inflammation. On theoretical grounds they have been supposed useful, because their continual use leads to a diminution of the fibrin of the blood, which, in acute inflammation, is augmented in quantity; and also because coagulable lymph, a product of inflammation, is soluble in alkaline solutions. The latter observation led Mascagni[1] to propose the use of alkalies in acute inflammatory disease; and in an epidemic pulmonary affection which, in 1800, made great ravages in the district of Chiudino, in Tuscany, the practice proved highly successful, as also in dropsy induced by obstruction of the lymphatic vessels and glands, from depositions of coagulable lymph in consequence of an inflammatory diathesis.

7. As a resolvent and sorbefacient, in glandular and visceral enlargements of a non-malignant character.

8. As an alterative and antacid in rheumatic and gouty inflammation, especially when accompanied with deposits of lithic acid in the urine.

In most of the cases in which the alkalies are indicated, it will be found advisable to employ them in the carbonated state; for in this form they are less caustic, and can therefore be given in larger doses, while their remote or constitutional effects are probably equally powerful.

2. *Salia neutra et media. The alkaline and earthy salts.*—This division includes the neutral and indifferent combinations of the alkalies and earths with acids, as well as some of the acidulous or supersalts of the alkalies.

The following is a list of the officinal substances of this order:—

Inorganic.

Potassæ sulphas.
Potassæ bisulphas.
Sodæ sulphas.
Magnesiæ sulphas.
Alumen.
Potassæ nitras.
Sodæ nitras.
Potassæ chloras.
Sodæ phosphas.
Sodæ biboras.
Sodii chloridum.
Ammonii chloridum.
Barii chloridum.
Calcii chloridum.
Potassii bromidum.
Potassii iodidum.

Organic (vegetable).

Potassæ acetas.
Sodæ acetas.
Ammoniæ acetas.
Potassæ tartras.
Potassæ bitartras.
Potassæ et sodæ tartras.
Potassæ citras.
Sodæ citras.
Ammoniæ citras.

The alkaline and earthy salts act both physically and chemically on the living tissues with which they are placed in contact.

---

[1] *London Medical Gazette*, vol. xiv. p. 714, Aug. 16, 1834.

Their physical or endosmotic influence has been already noticed (see pp. 95 and 96).

Their chemical influence is not very energetic, and the precise changes which they effect have not been carefully examined. The compounds which the salts form with the organic textures are more permanent, and less disposed to undergo putrefaction, than the textures alone are; and hence the salts act as antiseptics (see p. 167).

All salts[1] (even common salt), when swallowed in excessive quantities, operate as irritant poisons; and some (as chloride of barium) are poisonous even in small doses.

In certain doses, most salts act as purgatives: when they do this, they are evacuated by the alimentary canal. Administered in smaller doses, they do not purge, but become absorbed, and are subsequently eliminated by the excreting organs, especially by the kidneys.[2] In this case, some of the salts (*e. g.* the alkaline acetates, citrates, and tartrates,) are oxidized during their passage through the system.

In the blood, the salts act both physically and chemically. Their physical influence on the blood-corpuscles is endosmotic (see pp. 96 and 112). When a saline solution, having a greater specific gravity than that of the serum, is introduced into the blood, the corpuscles shrink or collapse; but, when the solution is very dilute, they become distended. The chemical influence of the neutral salts is exercised both on the blood-corpuscles and on the plasma: they brighten the red colour of the former, and, in general, lessen the quantity of spontaneously coagulating matter (fibrin) in the latter.

The *antiplastic* or *plastilytic effect* on the blood of nitre and sulphate of soda has been before noticed (see p. 113). This effect of salines is, however, probably neither constant nor universal; for Laveran and Millon state that, in acute pneumonia and articular rheumatism, Rochelle salt (sodæ potassio-tartras, *Ph. L.*) given so as to become absorbed, diminished neither the quantity of fibrin nor the buffy coat of the blood.[3]

When salts are added to the blood, they lessen or destroy the adhesiveness of the corpuscles for each other, and thereby separate and render them distinct. Now, as in buffy blood the corpuscles have an increased tendency to aggregate, and to separate from the blood, Mr. Gulliver[4] suggests, that probably the efficacy of saline medicines in inflammation depends on their correcting this disordered state of the blood.

The salts are eliminated by the different excretory organs, principally by the kidneys (see p. 105), on which they act as stimulants (see p. 114), and thus produce diuresis.

Many of them pass out unchanged; while others are eliminated in a more or less decomposed state (see p. 105). In the case of the neutral alkaline salts containing a vegetable acid,[1] as well as in that of sulphuret of potassium (which in part becomes converted into sulphate of potash—see p. 105), the salts suffer oxidation; but the conversion of the red ferridcyanide of potassium into the yellow ferrocyanide (see p. 105) may perhaps be regarded as a reducing process.

---

[1] In the human subject, death has resulted from the use of the following salts in excessive doses:—common salt, sulphate of magnesia, cream of tartar, nitre, sulphate of potash, and binoxalate of potash. These salts are, as is well known, innocuous in small doses. We infer the poisonous operations of all salts, in certain doses, partly from observation of their effects on men and animals, and partly from analogy.

[2] Laveran and Millon, in their experiments on Rochelle salt (sodæ potassio-tartras, Ph. L.) and sulphate of soda, found that when these salts acted as purgatives absorption did not take place (*Annuaire de Chimie*, 1845, p. 585).

[3] *Annuaire de Chimie*, 1845, p. 587.

[4] *The Works of William Hewson, F.R.S.* (Notes), pp. 41, 71, 229, and 231, Lond. 1846.

Most of the neutral alkaline salts containing a vegetable acid are converted, by oxidation, into carbonates (or bicarbonates), in which state they are found in the urine, to which they communicate an alkaline quality.[2] The acid salts are only partially decomposed; at least, this, according to Wöhler, is the case with cream of tartar: for he found that, after the use of this salt, the urine became alkaline, and, as long as it possessed this quality, it contained no tartaric acid; but, when it again became acid, tartaric acid was recognised in it.

The urine is not invariably rendered alkaline by the use of the vegetable salts of the alkalies. In 268 experiments with Rochelle salt (sodæ potassio-tartras, *Ph. L.*) Laveran and Millon found that the urine was rendered alkaline in 175 cases, was acid in 87, and neutral in 6 cases. When, from the largeness of the dose or the condition of the patient, the salt acted as a purgative, it was usually carried off by the bowels, and did not communicate an alkaline quality to the urine. But, on the contrary, when it did not excite purging, it became absorbed, and rendered the urine alkaline. These opposite effects were probably referable to differences in the density of the saline solutions employed: those which were denser than the serum of the blood provoking purgation, while those which were less dense became absorbed (see p. 95).

[It must not, however, be supposed that the potassio-tartrate of soda does not produce an alkaline state of the urine even when it purges freely. Any one using a seidlitz powder as a purgative will pass alkaline urine during the elimination of the salt from the system.—ED.]

Cherries, strawberries, and probably most sweet fruits, render the urine alkaline. They are enabled to do this in consequence of containing a vegetable alkaline salt, which in traversing the system becomes converted into a carbonate. Those fruits which contain only or chiefly free acid,—as currants and lemons,—do not render the urine alkaline.

In order to become converted into carbonates (or bicarbonates) the vegetable alkaline salts must undergo oxidation in the system, by which the vegetable acid is resolved into carbonic acid and water. Acetic acid ($C^4H^3O^3$) requires eight equivalents of oxygen; citric acid ($C^{12}H^5O^{11}$), a tribasic acid, eighteen equivalents of oxygen; and tartaric acid ($C^8H^4O^{10}$), a bibasic acid, ten equivalents, to convert them respectively into carbonic acid and water.

The salts are employed therapeutically for various purposes, of which the following are the chief:—

1. As cooling or antiphlogistic cathartics or laxatives, in febrile or inflammatory complaints. They are also useful in other cases where a mild action on the gastro-intestinal mucous membrane is required, along with a gently

---

[1] The alkaline oxalates are probably exceptions to this statement. After the ingestion of rhubarb-tart, or sorrel (*Rumex acetosa*), a crystalline deposit of oxalate of lime is found in the urine. Dr. Letheby (*Lond. Med. Gaz.* Jan. 22, 1847, pp. 153–4) states that he detected oxalate of urea also in the urine.

[2] Wöhler states, that after the use of several drachms of these salts the urine effervesces, on the addition of an acid, like champagne.

resolvent effect on the system, as in liver complaints. The sulphates of soda, magnesia, and potash, the alkaline tartrates, and the phosphate of soda, are the salts in most frequent use as cathartics.

Alum acts as an astringent (see p. 162).

2. As diuretics in dropsies, and also in other complaints attended with deficient secretion of urine. The density of saline solutions given to act on the kidneys should be less than that of the serum of the blood (see p. 95). The salts in most frequent use as diuretics are nitrate of potash, and the alkaline acetates, citrates, and tartrates.

3. In fevers, salines are in almost universal use. They are employed with the obvious effect of promoting the action of the secreting organs, and with the supposed effect of altering the crasis of the blood.

Dr. Stevens[1] explains the efficacy of salines in malignant fevers by supposing that they restore to the blood the saline matter in which, in these cases, he declares this fluid to be deficient, as is evinced by the dark colour of the circulating fluid. To the saline impregnation he ascribes the vermilion red colour, and some other properties of the blood, and he regards the black colour of this liquid as a certain proof of the loss or diminution of its saline ingredients.

4. In inflammation, the salines are used as antiphlogistics, liquefacients, and resolvents (see p. 179).

5. To restore the saline qualities of the blood in malignant cholera. In this disease the blood is remarkably black, incapable of coagulating, and contains more albumen and hæmatosin, but less water and saline parts, than natural; while the enormous discharges from the bowels consist of a weak solution of albumen containing the salts of the blood.[2] The obvious indications, therefore, in the treatment of this disease, are, to restore the water and saline matters to the blood. Hence originated what has been called the *saline treatment* of cholera. This, at first, consisted in the exhibition of certain alkaline salts by the mouth, and in the form of enemata. The following are formulæ which have been recommended:—

Take of Carbonate of soda.........half a drachm.
Chloride of sodium ......a scruple.
Chlorate of potash.........seven grains.

Dissolve in half a tumblerful of water.

This to be repeated at intervals of from fifteen minutes to an hour, according to circumstances (Dr. Stevens, *op. cit.* p. 459).

Take of Phosphate of soda .... 10 grains.
Chloride of sodium............ 10 grains.
Carbonate of soda .... 5 grains.
Sulphate of soda............... 10 grains.

Dissolve in six ounces of water.

The mixture to be repeated every second hour (Dr. O'Shaughnessy, *op. cit.* p. 54).

This plan, however, was followed by that of injecting saline solutions into the veins, which was, I believe, first practised by Dr. Latta.[3] The quantity of saline solution which has been in some cases injected is enormous, and almost incredible. In one case, "120 ounces were injected at once, and repeated to the amount of 330 ounces in twelve hours. In another, 376 ounces were thrown into the veins between Sunday at 11 o'clock, A.M. and Tuesday at 4 P.M.: that is, in the course of fifty-three hours, upwards of thirty-one pounds. The solution that was used consisted of two drachms of chloride of sodium, and two scruples of carbonate of soda, to sixty ounces of water. It was at the temperature of 108° or 110° F."[1] In another series of cases, 40 lbs. were injected in twenty hours: 132 ounces in the first two hours; 8 lbs. in half an hour![2] The *immediate* effects of these injections, in a large majority of cases, were most astonishing: restoration of pulse, improvement in the respiration, voice, and general appearance, return of consciousness, and a feeling of comfort. In many instances, however, these effects were only temporary, and were followed by collapse and death. In some, injurious consequences resulted, as phlebitis,[3] drowsiness,[4] &c. The reports as to the ultimate benefit of the saline treatment in cholera are so contradictory, that it is exceedingly difficult to offer to the student a correct and impartial estimate of its value. That it failed in a large proportion of cases after an extensive trial, and greatly disappointed some of its staunchest supporters, cannot be doubted.[5] Dr. Griffin[6] states, that all the published cases of injection which he can find recorded amount to 282, of which 221 died, while 61 only recovered: but he thinks that the average recoveries from collapse by this method of treatment "far exceeded the amount of any other treatment in the same disease, and under the same circumstances."

---

[1] *Observations on the Healthy and Diseased Properties of the Blood*, p. 356, *et. seq.* Lond. 1832.

[2] Dr. O'Shaughnessy, *Report on the Chemical Pathology of the Malignant Cholera*, 1832.

[3] *Lond. Med. Gaz.* vol. x. p. 257.

[The solutions used for injecting the veins have been of too low a specific gravity, and such as to injure the blood corpuscles by too rapid endosmose. A specific gravity of about 1030 appears indicated, whereas Dr. Latta's fluid was about 1004 to 1005. A heavy fluid of 1030, composed merely of water and salts, would mix more easily with the blood than the watery injections; it would rapidly diffuse itself, and in all probability produce its vivifying effects in small quantity.[7]—ED.]

6. As antilithics and lithontriptics. The acetates, citrates, and tartrates modify the composition of the urine, and communicate to it an alkaline quality (see p. 184). Hence they are used as antilithics or lithontriptics in the lithic acid diathesis (see *Lithontriptica*).

7. As resolvents, liquefacients, sorbefacients, and alteratives in glandular enlargements, and in chronic inflammation of a scrofulous or rheumatic character.

3. *Iodica et bromica. Iodine, bromine, and their compounds.*—This section includes the following substances:—

Iodinium.
Brominium.

Potassii iodidum.
Potassii bromidum.

The iodides and bromides of lead, iron, and mercury, may be conveniently referred to the sections including their metallic bases.

The chemical action on the animal tissues of iodine and bromine has been already noticed (see p. 97). The alkaline iodide and bromide act in an analogous manner to the other alkaline salts (see p. 182).

The iodica and bromica are absorbed and pass into the blood, in which fluid several of them have been detected (see p. 104). Some (*e.g.* iodine and bromine), if not all of them, enter the blood in a state of combination. From analogy rather than from observation, the iodica and bromica are supposed to lessen the amount of solid constituents (especially the fibrin and corpuscles), and to increase the proportion of water.[1] The augmented secretions, the thinness and wasting, and the disappearance of scrofulous and other swellings, observed under their use, evince their liquefacient and antiplastic operation. They are thrown out of the system by the excreting organs (see p. 106).

---

[1] *Lond. Med. Gaz.* vol. x. p. 257.
[2] *Ibid.* vol. x. p. 379–80.
[3] *Ibid.* vol. x. p. 453.
[4] *Ibid.* vol. x. p. 447.
[5] *Ibid.* vol. x. p. 717.
[6] Dr. Griffin, *Recollections of Cholera*, in *Lond. Med. Gaz.* vol. xxii. p. 319.
[7] *Lancet*, Oct. 1st, 1853.

Iodine is an important topical agent, and as such has already been noticed (see p. 162).

The iodica and bromica are used in medicine as alteratives, liquefacients, resolvents, and sorbefacients. They are useful in aiding the removal of some of the products of inflammation, such as serum, liquor sanguinis, and the healthier kind of fibrin and exudation corpuscles. They are chiefly serviceable in scrofulous, rheumatic, and syphilitic inflammations. They are not adapted for acute inflammation, but for inflammation of a chronic character. They are also serviceable in relieving certain non-malignant alterations of texture referable not to inflammation, but to perverted nutrition, and which are accompanied with increased deposit of solid matter,—such as induration with enlargement or swelling of organs, especially of the lymphatic glands, liver, and spleen. It is doubtful whether they have any influence over that kind of increased nutrition which is attended with hypertrophy.

[The power of the iodica as resolvents appears greatly increased by combination with the caustic alkalies. The union of the iodide of potassium with liquor potassæ forms a compound under the use of which glandular and other swellings occasionally become removed with a rapidity seldom observed when either remedy is exhibited alone.—ED.]

4. *Sulphurosa. Sulphur, sulphuretted hydrogen, and the alkaline sulphurets.*—This section includes the following substances:—

Sulphur.
Acidum hydrosulphuricum.
Potassii sulphuretum.
Ammonii sulphuretum.
Aquæ sulphureæ seu hepaticæ.

These substances are referred to the *spanæmica* on account of their alterative, resolvent, and liquefacient properties, and their consequent analogy to the substances contained in the preceding sections. No analysis of the blood of animals under their influence has hitherto been effected.

By the inhalation of sulphuretted hydrogen gas (acidum hydrosulphuricum), or of the vapour of hydrosulphuret of ammonia (sulphuret of ammonium), as well as by the ingestion of the alkaline sulphurets, the blood assumes a dark colour,—an effect which, in the case of sulphuretted hydrogen, Liebig[2] ascribes to the action of this gas on the iron in the blood.

When the alkaline sulphurets are swallowed, a portion of them suffers decomposition by the acids of the stomach, and, in consequence, an evolution of sulphuretted hydrogen takes place. The undecomposed portion becomes absorbed, and is eliminated by the kidneys; but, during its passage through the system, some of it undergoes oxidation, and is converted into sulphate.

Sulphur taken into the stomach is, for the most part, evacuated by the bowels; but a portion becomes absorbed, and may be detected in the secretions; in the urine it is found as sulphate and sulphuret.[1] It is probable, therefore, that, by the mutual action of sulphur and the soda of the bile, sulphuret of sodium and sulphate of soda are formed, and that these are subsequently absorbed.

---

[1] Simon's *Animal Chemistry*, vol. i. p. 307, English Translation by Dr. Day.

[2] *Animal Chemistry*, p. 274, Lond. 1842.

Sulphuretted hydrogen gas and the vapour of sulphuret of ammonium, when inhaled, act as narcotic or narcotico-irritant poisons; and the alkaline sulphurets, if swallowed in sufficient quantities, operate as narcotico-irritants.

The *sulphurosa*, when employed medicinally, promote the action of the secreting orgrns; their influence being directed principally to the skin and mucous membranes. They have been supposed to possess a specific stimulant influence over the pelvic venous system. Their influence over the skin is undoubted; and their efficacy in chronic cutaneous diseases has long been established. In these maladies, sulphur and the sulphureous waters are employed internally; while, as external remedies, solutions of the alkaline sulphurets and the sulphureous waters are used. On account of their influence over the mucous membranes, the sulphurosa have been employed in chronic bronchial affections: but, in this country, they are rarely administered in these cases.

In hemorrhoidal affections and uterine obstructions (chlorosis and amenorrhœa), sulphur and the sulphureous waters are frequently resorted to on account of their supposed stimulant influence over the pelvic venous system.

Lastly, solutions of the alkaline sulphurets are used as baths where the skin is impregnated with lead (see p. 165).

5. *Mercurialia et antimonialia. Mercurials and antimonials.*—This section includes the following substances.

Mercurialia.	*Antimonialia.*
Hydrargyrum.	Antimonii sesquioxydum.
Hydrargyri oxydum.	Antimonii oxysulphuretum.
Hydrargyri binoxydum.	Pulvis antimonii compositus (*Ph. Lond.*)
Hydrargyri chloridum (*calomel*).	Potassæ antimonio-tartras (*Ph. Lond.*)
Hydrargyri bichloridum.	
Hydrargyri iodidum.	
Hydrargyri biniodidum.	

The topical action of these agents is not uniform. Mercury, so long as it retains its metallic or reguline character, is apparently inert. All the others probably exercise a local chemical influence; and of these, bichloride of mercury is the most active (see p. 98). Chloride of mercury (calomel), when swallowed, suffers some chemical change, and yields a soluble mercurial compound (see p. 92.)

The mercurials and antimonials become absorbed into the blood, and are afterwards eliminated by the excretory organs. Mercury and antimony have been detected in the blood, solids, and urine of patients to whom preparations of these metals had been administered (see pp. 104 and 105). Mercury has also been recognised in other secretions (see p. 106).

---

[1] Wöhler (Tiedemann's *Zeitschrift*, Bd. i. S. 131) found in the urine of a dog, to whom he had given a drachm of flowers of sulphur, an unusual quantity of sulphate, and likewise some sulphuret; for sulphuretted hydrogen was evolved on the addition of hydrochloric acid. More recently, MM. Laveran and Millon (*Annuaire de Chimie*, 1845, p. 588) state, as the result of their experimental observations, that sulphur is neither oxidised, nor otherwise modified, and that it does not become absorbed. But their negative results cannot disprove the positive ones of so accurate an observer as Wöhler. Moreover, their statements are in opposition to the common observation of the odour of sulphuretted hydrogen evolved by the breath and secretions of persons who have been using sulphur internally.—Unoxidised sulphur has been detected in healthy urine by Dr. Ronalds (*Phil. Trans.* 1846).

The mercurials and antimonials promote secretion and exhalation generally, though they do not equally affect all the secreting and exhaling organs. The specific effect of mercurials on the mouth (ptyalism), and of antimonials on the skin (diaphoresis), well known.

The effects produced on the blood by the protracted use of these agents have not been chemically investigated. The older writers[1] state that mercury produces a watery and dissolved condition of the blood; and the same kind of opinion, expressed in a different form of language, is held by modern writers.[2] I am unacquainted with any chemical observations as to the state of the blood after the protracted use of antimonials; but, from analogy, it is inferred to be similar to that caused by mercurials.

In the treatment of acute inflammation with fever, mercurials and antimonials constitute the most important of our medicinal remedies. Antimonials are principally adapted for relieving the febrile symptoms, reducing the force of the heart's action, moderating the heat of skin, and promoting sweating: in inflammation, therefore, their beneficial effects are best seen in the early stages of the disease. Over the effused products of inflammation they have little influence. Mercurials, on the other hand, are useful in inflammation principally by their influence over the products of this malady: they both check effusion and promote the removal of the lymph already deposited. Antimonials, therefore, are said to be useful in inflammation and fever by their contra-stimulant (see p. 100), sedative, and sudorific influence; mercurials, by their alterative, sorbefacient, and resolvent effects. Antimonials are most useful in continued fever, rheumatic inflammation, and bronchitis: mercurials, on the other hand, are more fitted for inflammations having a tendency to terminate in effusions of coagulable lymph,—as iritis, inflammation of the serous membranes, and croup; in syphilitic inflammation; and in indurations and enlargements of organs.

Both antimonials and mercurials are used as evacuants: the former, as emetics, sudorifics, and expectorants; the latter, as purgatives and sialogogues.

SUB-ORDER γ. SPANÆMICA ANTISPASMODICA.—Antispasmodic spanæmics. This sub-order includes the following substances:—

Acidum arseniosum.
Cupri sulphas.
Cuprum ammoniatum.
Argenti nitras.
Bismuthi trisnitras.
Zinci oxydum.
Zinci sulphas.

All these agents exercise a topical chemical influence over the organised tissues (see pp. 97 and 168), in virtue of which they are used as caustics (see p. 161). Swallowed in sufficient doses, they act as irritant poisons.

When taken into the stomach, they suffer, in this organ or in the intestinal canal, more or less chemical change (see p. 92), and, in this altered state, become absorbed. The metallic bases of the substances comprising this sub-order have been detected in the blood, and most of them in the solids and urine (see pp. 104 and 105).

---

[1] "A long and large use of mercury will turn the whole mass of blood into a mere watery colluvies" (Huxham, *Essay on Fevers*, p. 46, 3d Lond. edit. 1757).

[2] See *post*, art. *Hydrargyrum*. Also Dr. Farre, in Ferguson's *Essays on the Diseases of Women*, part i. p. 216; Dietrich, *Die Merkurial-Krankheit*, p. 80, Leipzig, 1837; and Simon, *Animal Chemistry*, vol. i. p. 307, English translation by Dr. Day. Dr. Farre states, that a course of mercury diminishes the number of blood-corpuscles; and he says that he gave mercury to a full plethoric woman, and "in six weeks blanched her as white as a lily."

All these agents, by long-continued use, impoverish the blood—that is, act as spanæmics; but the precise changes which they effect have not been investigated.

They exercise a well-marked influence over the nervous system. This is shewn by the cramps, convulsions, paralysis, and even narcotism, which they induce when swallowed in poisonous doses; and by their efficacy in the treatment of some morbid conditions of this system,—for example, chorea and hysteria, whence they have been denominated *antispasmodics*. Thus chorea is cured by zinc and arsenic; while epilepsy is frequently benefitted or even cured by arsenic, zinc, copper, or silver.

These agents are also remarkable for their curative influence in agues and other periodical diseases, in consequence of which they have been denominated *tonics*.

SUB-ORDER δ. SPANÆMICA SATURNINA.—The saturnine or plumbeous spanæmics. The following are the preparations of lead commonly used as medicines:—

Plumbi oxydum (*lithargyrum.*)
Plumbi iodidum.
Plumbi carbonas.
Plumbi acetas.
Plumbi diacetas.

All these agents exercise a greater or less chemical influence over the organised tissues and fluids; by which, changes are effected both in the preparations themselves and in the animal tissues and fluids (see pp. 92 and 97). Mialhe[1] asserts, that all the salts of lead, even the sulphate, are partially or wholly decomposed and converted into chlorides by the alkaline chlorides contained in the animal fluids; and he, therefore, doubts the specific antidotal property of sulphuric acid. Dr. C. G. Mitscherlich's observations on the action of acetate of lead on animal matter will be noticed hereafter (see *Plumbi acetas*).

The compounds of lead, formed by the action of the tissues and fluids of the alimentary canal on the preparations of lead, are some soluble, others insoluble: the former are absorbed, the latter rejected.[2]

The absorption of lead is proved by its subsequent detection in the blood,[3] solids, and excretions (see pp. 105 and 106). Dr. Todd,[4] in a case of chronic saturnine poisoning, found lead "in great quantity in the brain, and in the lung this metal was found in still greater proportion;" and more recently, Dr. Inmann[5] detected lead in the cerebellum of a painter.

In saturnine cachexy, Andral and Gavarret[6] invariably found a deficiency of blood-corpuscles. The following table shows the mean composition, according to these authors, of healthy blood and of the blood of a patient where this cachexy constituted the sole malady.

---

[1] *Mémoire sur les Emanations du Plomb et l'Absorption des Médicaments*, Paris, 1844 (noticed in the *Supplément au Dictionnaire Universel de Matière Médicale*, p. 570, Paris, 1846).

[2] In patients affected with saturnine colic, lead has been found in the fæcal matters by Mérat, by Chatain (*Supplément*, supra cit. p. 571), and by Duvergie (Tanquerel des Planches, *Traité des Maladies de Plomb*, t. i. p. 325).

[3] Cozzi (*Lancet*, May 11, 1844, p. 227) detected a salt and an oxide of lead in the blood of a patient labouring under lead colic. They were in combination neither with the hæmatosin nor the fibrin, but with the albumen.

[4] *Practical Remarks on Gout, Rheumatic Fever, and Chronic Rheumatism of the Joints*, pp. 23 and 24, Lond. 1843.

[5] *London Medical Gazette*, August 28, 1846, p. 389.

[6] *Ann. de Chimie et de Physiq.* t. lxxv. pp. 309–310, November 1840.

	Healthy blood.	*Blood in saturnine cachexy.*
Fibrin	3	2·8
Blood-corpuscles	127	83·8
Solid residue of the serum	80	78·1
Water	790	835·3
	1000	1000·0

The blood appears also to have suffered an alteration in some other respects; for the serum is of a dirty or earthy-yellow hue. The skin, the conjunctival membrane, and the viscera, have the same tint, apparently in consequence of being impregnated with blood altered in its colour. This, then, is the source of the so-called *icterus saturninus*.

Lead is eliminated from the system by the urine (see p. 105), by the skin[1], and by the milk (see p. 106).

When the preparations of lead are administered for therapeutical purposes, their primary effects, for which they are usually employed, are a diminution in the volume and frequency of the pulse, and in the activity of the functions of secretion. These are the general though not universal effects. Hence the preparations of lead are described as being sedative and astringent—terms which imperfectly express the real character of the effect. When the system is under the influence of this metal, the pulse is usually smaller and sometimes slower than natural. Tanquerel des Planches has seen it reduced to 55, 50, 45, and even to 40 beats per minute. The secretions of the mucous membranes and their glands are diminished; the mouth and nose become drier; the bowels constipated; the stools harder and of a paler yellow colour; and the urine is lessened in quantity. These effects, however, are by no means constant or uniform.

When the system is impregnated with lead, the presence of this metal may be manifested by a specific action on the solids and liquids of the organism before the development of the saturnine diseases, and which is called by Tanquerel des Planches *primitive saturnine intoxication*. The characteristic phenomena of this are the following:—

1st. Saturnine coloration of the gums, of the buccal mucous membrane, and of the teeth. A narrow leaden-blue or slate-blue line,[2] from one-twentieth to one-sixth of an inch in breadth, is formed on the margins of the gums nearest to two or more teeth (usually the incisors) of either jaw. The rest of the gums are of a bluish-red tint. I have seen the mucous membrane lining the lips and part of the cheek stained blue, like the edges of the gums. The teeth, especially at their lower part or neck, are frequently more or less deeply stained brown. The blue coloration depends on the presence of sulphuret of lead.[1]

---

[1] The elimination of lead by the skin is shown by the repeated re-formation of sulphuret of lead during the time the patients are using the sulphuretted baths (Mialhe, op. cit.; Taylor, *On Poisons*, p. 449).

[2] The presence of this line is fully described by Tanquerel des Planches, in his *Traité des Maladies de Plomb*, vol. i. p. 3, Paris, 1832; and by Dr. Burton, in a paper read to the Royal Medical and Chirurgical Society, Jan. 14, 1840 (*Medico-Chirurgical Transactions*, vol. xx. Lond. 1840.)

Dr. Chowne[2] denies that the presence or absence of the blue line on the margin of the gums has any certain connection with the administration or non-administration of lead. On this point I may observe, that I have satisfied myself that in several cases in which the blue line on the gums, and even the slate-blue staining of the lips, were observed, no evidence of poisoning by lead could be obtained. In most of the cases there were no constitutional symptoms of lead poisoning. In one case (that of a woman), an out-patient of the London Hospital, who applied for relief in consequence of suffering with dyspepsia, the blue line on the gums, and the blue staining of the lips, were more marked than in any cases of positive lead-poisoning which I have seen. I analysed the water she used, and the beer and gin which she drank, without gaining the least evidence of the presence of lead. In another case (a private patient, labouring under organic disease of the brain), I detected traces of lead in the bottled soda water of which she had partaken; but I am persuaded that this was an accidental circumstance. On the other hand, in every case of lead-poisoning which I have met with, and they are not a few, and in several cases in which sugar of lead, in large doses, had been taken medicinally for many days continuously, I have observed the blue line. It is stated[3] that a similar blue mark has been noticed in poisoning by mercurial compounds. In many cases of mercurial ptyalism, however, I have in vain looked for it.

To what is the formation of the blue sulphuret of lead owing? Tanquerel des Planches ascribes it to the action of sulphuretted hydrogen (evolved by the decomposing fragments of food lodged between the teeth) on the saturnine particles which pass through the mouths of those who respire or swallow lead. May it not be due to the action of sulphuretted hydrogen on lead contained in the saliva and buccal mucus?

2d. Saturnine taste and breath. Workmen who are under the influence of lead complain of a peculiar taste; and their breath has a peculiar odour (called by Tanquerel des Planches the *saturnine breath*).

3d. Saturnine icterus. This has been already noticed.

4th. Saturnine emaciation. This usually accompanies or follows the saturnine icterus. Although it is general, it is most evident in the face, which becomes wrinkled, and gives to the individual a more aged and care-worn appearance.

5th. State of the circulation. This has been before alluded to. The pulse is usually smaller, sometimes slower, and occasionally irregular.

These phenomena of primitive saturnine poisoning form, according to Tanquerel des Planches, the prodromi or forerunners of the saturnine maladies.

Poisoning by lead presents the four following distinct forms of disease, each of which may exist alone, or may be complicated with one or more of the others, or may follow the others, without, however, having any definite order or succession.

1. Lead colic; *colica saturnina; c. pictorum; c. pictonum.* This is by far the most frequent of the diseases.

2. Arthralgia; *arthralgia saturnina; rheumatismus metallicus* of Sauvages. In frequency, this is next to colic.

3. Paralysis. This may affect either the motility or the sensation of parts:

---

[1] By the action of oxygenated water, the blue substance is converted into the white sulphate of lead. By digesting the gums and teeth of a colour-grinder, who died from the effects of lead, with a solution of sulphuretted hydrogen for twenty-four hours, those parts of the gums which had not before presented the blue mark acquired a deep blue tint (Tanquerel des Planches, op. supra cit. vol. i. p. 6).

[2] *Lancet*, Oct. 26, 1844, p. 145.

[3] Taylor, *On Poisons*, pp. 384 and 488.

in the former case it is called paralysis of motion, or simply saturnine paralysis (*paralysis saturnina*); in the latter case it is termed *anæsthesia saturnina*. Paralysis occurs next in frequency to arthralgia.

4. Disease of the encephalon; *encephalopathia saturnina*. This, which is the least frequent of all the forms of saturnine poisoning, is manifested by different morbid phenomena; viz. by delirium, by coma, or by convulsions, with or without the loss of one or more of the senses.

The objects for which the preparations of lead are employed in medicine are few. We use them chiefly as sedatives, as astringents, and desiccants. The diseases, also, for which we resort to them are few: they are chiefly hemorrhages and fluxes. We apply them topically when we can get with safety at the affected part; and, on other occasions, we administer them internally. In the latter cases, we almost exclusively employ the acetate. Although the preparations of lead are more serviceable in asthenic cases, they may be administered with safety in sthenia, for which their sedative influence adapts them.

In hemorrhages (as from the lungs, uterus, &c.) the acetate of lead is serviceable both by its sedative and astringent influence: by the former, it is useful in reducing the force and frequency of the circulation; by the latter, it serves to lessen the volume of the bleeding vessels.

In fluxes, the preparations of lead are chiefly beneficial by their astringent influence: they are more serviceable when they can be applied directly to the affected parts. We use them in bronchial, gastric, intestinal, and vaginal fluxes: in the three former cases the acetate is employed, generally in combination with opium. In leucorrhœa, acetate and diacetate of lead are used as topical applications. In ophthalmic practice, the employment of the acetates of lead is objectionable on account of the opaque and generally indelible depositions their solutions leave on abraded or ulcerated spots of the conjunctiva or cornea.

Lead-washes are useful as cooling and sedative applications in superficial inflammation, in contusions, fractures, excoriations, &c. In profuse discharges from the skin (as in eczema and impetigo), the preparations of lead are useful as desiccants.

ORDER 4. HÆMATINICA (*αἱματινικά*, from *hæmatin*, *αἱμάτινα*, *the red colouring matter of the blood*). *Tonica analeptica*.—Medicines which augment the number of blood-corpuscles or the amount of hæmatin in the blood. This order is exclusively composed of iron and its compounds: *ferruginea; martialia; chalybeates*.

The following is a list of the more frequently employed substances composing this order:—

Ferrum.
Ferri oxydum nigrum.
Ferri sesquioxydum.
Ferri sesquichloridum

Ferri iodidum.
Ferri carbonas.
Ferri sulphas.
Ferri ammonio-citras.
Ferri-ammonio-tartras.

Ferri potassio-tartras.
Aquæ ferruginosæ.
  α. carbonicæ.
  β. vitriolaceæ.

The topical action of these chalybeates is very unequal. Iron, so long as it retains its metallic state, acts mechanically only. The oxides of iron act very mildly as topical agents. The sesquichloride and sulphate, however, are caustics and astringents.

The salts of iron produce a black stain when applied to the tongue, and communicate a dark colour to the stools. The latter effect was formerly ascribed to the production of the black oxide of iron;[1] but, according to Kersten,[2] whose opinion has been adopted by Berzelius, it depends on the formation of sulphuret of iron by the action of an alkaline sulphuret on the ferruginous salt.[3]

The preparations of iron, when taken into the stomach, are partly absorbed, partly evacuated, sometimes more or less altered, with the stools. The red colour which the sesquioxide of iron communicates to the stools of children, and the black colour of the stools after the employment of the salts of iron, are proofs of the presence of iron in the alvine discharges. The detection of iron in the blood, urine, and milk (see *ante*, pp. 105 and 106), after the use of chalybeates, demonstrates the absorption of iron.

The constitutional effects of iron are best observed in anæmia. If, in this condition of system, chalybeates be administered, the appetite increases, digestion is promoted, the pulse becomes fuller and stronger, the skin assumes its natural tint, the lips and cheeks become more florid, the temperature of the body is increased, the œdema disappears, and the muscular strength is greatly augmented. These effects are mainly due to the alteration in the composition of the blood. This is shown by the healthy vermilion tint which the patient acquires, as well as by the chemical analysis of the blood.

The remarkable change effected in the composition of the blood by the use of iron is well shewn in the following table:—

COMPOSITION OF THE BLOOD OF A CHLOROTIC GIRL.

	Before the use of iron.	*After the use of iron.*
Water	871·500	806·500
Solid constituents	128·500	193·500
Fibrin	2·080	1·200
Fat	2·530	2·299
Albumen	79·820	81·230
Globulin	30.860	90·810
Hæmatin	1·431	4·598
Extractive matters and salts	11·000	9·580
Colouring matter contained in the hæmatoglobulin	4·4$\frac{2}{3}$	4 8$\frac{2}{3}$

The girl took two ounces of the tincture of iron and sixty-four grains of metallic iron in seven weeks. "This change in the composition of the blood," observes Simon,[4] from whom the case is quoted, "is truly surprising, and affords an excellent illustration of the wonderful effects of certain remedies. The amount of solid constituents is increased by nearly one-half, and the increase of the hæmatoglobulin is likewise extraordinary. In this, as well as in Andral and Gavarret's observations, the quantity of the fibrin is diminished:

---

[1] Guersent, *Dict. de Médecine*, art. *Fer*, t. viii. p. 529, 1823.—Barruel (Trousseau and Pidoux, *Traité de Thérapeut.* t. ii. 1e part. p. 186,) ascribes the dark colour to the union of the oxide of iron with gallic or tannic acid contained in the food.

[2] Simon's *Animal Chemistry*, translated by Dr. Day, Vol. ii. 389–390.

[3] The blackening may be produced by the action on the ferruginous salt either of hydrosulphate of ammonia (sulphuret of ammonium), which frequently occurs in the intestinal canal, or of the sulphuret of potassium or of sodium (formed by the decomposition of the corresponding sulphate). Sulphuret of iron sometimes appears as a black or blackish-blue pigment on the walls of unhealthy fetid abscesses, and as a slate-grey pigment on the surface of the liver, spleen, and intestinal canal, when no ferruginous compounds have been swallowed. In such cases, it is formed by the action of hydrosulphuret of ammonia on the blood-pigment (see Vogel's *Pathological Anatomy*, translated by Dr. Day, pp. 194–196, and 396, Lond. 1847.)

[4] *Animal Chemistry*, translated by Dr. Day, vol. i. pp. 310–313, 1845.

the proportion of the hæmatin to the globulin is however slightly, although not materially, increased. The changes in the condition of the patient kept pace with those of the blood. Before, she was pale, and her lips colourless; now, she presented a really blooming appearance. Andral and Gavarret have arrived at perfectly analogous results."

The menstrual function is frequently either entirely suspended in anæmia, or the discharge is small in quantity, and of a pale watery character. The restoration of the function and the improvement in the quality of the evacuation, effected by the use of iron, are referable to the beneficial change produced in the quality of the blood.

The efficacy of purgatives in promoting the effect of the ferruginous compounds in anæmia, has been ingeniously explained by Dr. G. O. Rees.[1] By removing water from the blood, they increase the specific gravity of the plasma. This, then, by an endosmotic action, deprives the blood-corpuscles of their dilute watery hæmatin, which is replaced by the more dense liquor sanguinis. The corpuscles, when thus supplied with a liquor denser than the chyle, are in a condition to absorb, by an endosmotic action, the ferriferous chyle. After the long-continued use of the ferruginous compounds, we frequently find excitement of the vascular system (particularly of the brain): thus we have throbbing of the cerebral vessels, and sometimes pain in the head, a febrile condition of system, with a tendency to hemorrhage.

Mr. Carmichael[2] considers the sanguine temperament (marked by a high complexion, celerity of thought, remarkable irritability of fibre, and a quick pulse,) as depending on an excess of iron in the system; whereas the leucophlegmatic, or relaxed, temperament (characterised by a pale bloated countenance, dull eyes, mind heavy and slow in receiving and forming ideas, little irritability of fibre, and pulse small and feeble,) as depending on a deficiency of iron.

In the treatment of anæmia, iron acts, in part, as an aliment. It supplies to the blood-corpuscles an ingredient in which they are deficient, and it may, therefore, be said to serve as nourishment for them.

The condition in which the iron exists in the hæmatin is still a *questio vexata*; and, therefore, the most appropriate ferruginous compound for the treatment of anæmia must, for the present, remain doubtful. Experience, however, has fully proved that this condition of system may be cured both by metallic iron and by the ferruginous compounds; both by peroxide and persalts, and by protoxide and protosalts; both by insoluble and by soluble ferruginous preparations; and both by compounds which contain iron in the basic part, and by those which contain it in the acid part.

But, though all these substances are capable of acting as hæmatinics and of curing anæmia, they are not all equally eligible or efficacious. Some of them, in fact, do not possess any immediate or direct hæmatinic power,—as metallic iron and the insoluble ferruginous compounds; for metallic iron acquires medicinal activity only by decomposing water in the stomach, and combining with oxygen to form the protoxide of iron, which dissolves in the acid contents of the stomach, and in this way becomes absorbable, while hydrogen gas is evolved; and the insoluble ferruginous compounds, not being absorbable, cannot act on the general system; but, by the change effected in them by the acid liquors in the gastro-intestinal canal, they give rise to the formation of soluble compounds, which are absorbed; and in this way the insoluble ferruginous compounds indirectly or mediately act as hæmatinics. But, as they depend for their activity on the acidity of the gastro-intestinal juices, which is limited and variable, it is obvious that their operation is slow, and cannot be uniform.

---

[1] *London Medical Gazette*, April 4, 1845, pp. 758–59, and 853–4.

[2] *Essay on the Effects of Carbonate of Iron on Cancer*, Dubl. 1806, p. 396.

All the soluble ferruginous preparations which contain iron in the basic part,—such as the iodide, chloride, and sulphate,—possess medicinal activity, and act as hæmatinics. The chloride and sulphate are also powerful astringents, and, when swallowed in sufficient quantity, act as caustic and irritant poisons.

But of the soluble compounds containing iron in the acid part some are valuable as hæmatinics, such as the ammonio-citrate of iron and tartarized iron;[1] while others, such as ferrocyanide and ferridcyanide of potassium,[2] are useless as hæmatinics, and are not applicable, therefore, for the cure of anæmia.

By a careful attention to the known physiological effects of the ferruginous compounds, the indications and contra-indications for their use may be, in a great measure, ascertained.

The general indications for their use are debility, feebleness and inertia of the different organs of the body, atony (marked by a soft, lax, or flabby condition of the solids), and defect of the red corpuscles of the blood,—as where there is a general deficiency of this fluid (*anæmia; oligæmia*), or a watery condition of it (*hydræmia; serous crasis; leucophlegmatic temperament.*)

The contra-indications are the reverse of these: great strength and activity of organs, excessive tonicity (characterised by a firm and tense condition of the solids), and redundancy of the red corpuscles of the blood,—as in general excess of the blood (*plethora*), in fever, in acute inflammation, and in the sanguine temperament. To these may be added, congestion, or a tendency thereto, of important organs, especially of the brain and lungs, and intestinal irritation.

The following are some of the more important diseases in which chalybeates prove serviceable:—

1. In maladies attended with defect of the red corpuscles of the blood; as in anæmia, with or without irregularity of the uterine functions (chlorosis, amenorrhœa, dysmenorrhœa, and menorrhagia), and whether occurring spontaneously and without any obvious cause, or resulting from profuse discharges (hemorrhages, fluxes, as leucorrhœa, &c.), from food defective in either

---

[1] These compounds are probably decomposed by the acids of the gastric juice. Mialhe (*Traité de l'Art de Formules*, p. 165, 1845) assumes, that the vegetable acids of these salts, like those of the alkaline salts (see *ante*, p. 184), undergo oxidation in the system, and are converted into carbonates. But Wöhler states, that tartarized nickel (tartrate of nickel and potash), a salt analogous in composition to tartarized iron, is eliminated in the urine unaltered (see *ante*, p. 105).

[2] Ferrocyanide of potassium is eliminated in the urine unchanged, while the ferridcyanide is converted into the ferrocyanide (see *ante*, pp. 105 and 106). Mialhe asks why these cyanides of potassium and iron pass in the urine, "as Wöhler has incontestibly shown; and then replies, because they are not decomposed by the alkalies of the blood." But these compounds are not both eliminated in the urine: Wöhler distinctly states, that one only passes unchanged, as I have above stated.—It deserves notice, that Faraday (*Phil. Trans.* for 1846, p. 43) found that "every salt and compound containing iron in the basic part was magnetic," and pointed axially; whereas ferrocyanide and ferridcyanide of potassium pointed equatorially (see *ante*, p. 59), and were, therefore, diamagnetic.

quantity or quality, and from deficiency of light and pure air. In these cases, the use of iron, conjoined with sufficient nourishing food, pure air, abundance of light, and, when necessary, the employment of purgatives (see p. 195), proves curative. But, when the anæmia or hydræmia is dependent on organic diseases,—as cancer, granular degeneration of the kidney, or morbus cordis,—the use of iron can at best be palliative only.

In what way does iron relieve anæmia? Is it merely by supplying the ingredient in which the blood is deficient? I think not. Anæmia frequently occurs without any obvious cause; when there has been no deficiency of food, air, and light, and no profuse discharges. In such cases the disease cannot be ascribed to want of iron in the system,[1] but to some defect in the sanguification process: the iron which is taken in with the food has not been properly applied in the manufacture of hæmatin or red blood-corpuscles. In such cases the chalybeate medicine relieves the anæmia by correcting the defect in the blood-making process, the seat and nature of which are at present unknown.

2. In some chronic affections of the nervous system great benefit is obtained by the use of iron. Chorea, in a large number of cases, may be relieved, and oftentimes cured, by chalybeates; though, in general, I consider them inferior to arsenic, which usually cures chorea much more speedily and certainly than they do. Cases, however, sometimes occur in which the chalybeates are preferable; as where anæmia or partial paralysis coexists. When anæmia is present, iron is obviously indicated, and when paralysis accompanies the chorea, I regard arsenic as hazardous. Epilepsy and hysteria are other nervous affections which are sometimes benefited by a course of iron, especially when they are attended with anæmia or uterine obstructions. Of the efficacy of iron in the shaking palsy caused by the vapour of mercury I have had no experience.

3. In diseases of the spleen the ferruginous compounds are occasionally found useful. "I regard iron as a specific," says Cruveilhier,[2] "in hypertrophy of the spleen, or chronic splenitis; whether primitive or consecutive to intermittent fevers." After noticing the symptoms attending this condition (such as paleness of the lips, &c. great lassitude, abdominal and cephalic pulsations, brought on by the slightest exertion, pain at the left side, disordered state of the digestive organs, accelerated pulse, and heart easily excited), he goes on to remark, "By the aid of iron I have obtained the complete resolution of enlargements of the spleen, which have occupied half, or even two-thirds, of the abdomen."

Is not iron useful in these cases by removing the coexistent anæmia? In disease of the spleen, accompanied with enlargement of this organ, but unattended by anæmia, I have found it fail to give relief.

---

[1] The following is an illustrative case:—A girl, of about fifteen years of age, suffering under spasmodic torticollis, for which various modes of treatment had been unavailingly employed, applied at the London Hospital as an out-patient, and was placed under my care. I prescribed iron thrice daily. Under this plan she improved, though very slowly; and the use of the iron was steadily persevered in. At the end of nine months, during the whole of which time she was taking iron, she became anæmic. Her face and lips were completely blanched, and she had the other usual characteristics of a patient suffering with anæmia. In this case there could not have been any deficiency of iron. I made no alteration in the treatment, and in the course of a few weeks all the anæmic symptoms subsided, and the girl resumed her usual appearance.

[2] *Dict. de Médecine et de Chirurgie pratiques*, t. viii. p. 62.

It deserves to be noticed that in animals to which sulphate of iron had been given, Weinhold[1] found the spleen smaller and firmer than usual.

In hypertrophy of the liver iron has not been found as beneficial as in hypertrophy of the spleen.

4. Some years ago the preparations of iron were strongly recommended in cancer by Mr. Carmichael.[2] He employed (externally and internally) various ferruginous compounds—namely, the ferrotartrate of potash, the sesquioxide of iron, and the phosphates of iron. Whatever hopes may have at one time been entertained of these remedies as curative agents in this most intractable disease, they no longer exist. That these medicines are occasionally useful as palliatives by relieving the anæmia and improving the general health must be admitted; but they have no curative powers.

Dr. Walsh[3] considers the iodide of iron as specially appropriate in cases of cancer attended with anæmia.

5. In some intermitting diseases—namely, ague,[4] asthma, and tic douloureux—the ferruginous preparations have gained considerable repute. In the first of these maladies their use has of late years been almost wholly superseded by disulphate of quina and arsenic. In asthma, Dr. Bree,[5] who was himself a sufferer from the disease, regards iron as preferable to all other remedies. However, the experience of others has not confirmed his favourable opinion of it. The sesquioxide of iron has latterly been extensively employed, at the recommendation of Mr. B. Hutchinson,[6] in tic douloureux, and with variable success; in some cases acting in a most extraordinarily beneficial manner, in others being of no avail.

6. As astringents the sesquichloride and sulphate are used both as internal and topical agents. In mucous discharges from the genital organs, as gleet and leucorrhœa, the internal employment of the tincture of the sesquichloride of iron, sometimes conjoined with the tincture of cantharides, has been found highly useful. In spermatorrhœa, also, iron sometimes proves beneficial both by its astringent and by its tonic properties. In hemorrhage from the stomach the tincture of sesquichloride of iron serves the double purpose of a styptic and hæmatinic. Solutions of the sulphate and sesquichloride of iron have been employed as injections in discharges from the urethra and vagina; and the tincture of the sesquichloride is occasionally applied as a styptic or to repress the growth of spongy granulations. Lastly, Mr. Vincent[7] states that he has found great advantage from the employment of sulphate of iron (in the proportion of a grain of the salt to an ounce of water) in prolapsus ani. The patients should be kept in bed, and after the bowel has been cleansed out, a small quantity of the injection should be daily thrown up and retained.

7. In scrofula and rickets the long-continued use of ferruginous compounds, in some cases combined with alkalies or iodine, has appeared to me on many occasions to be highly beneficial. In these cases iron proves most serviceable

---

[1] *Versuch über d. Leben*, quoted by Richter, *Ausführliche Arzneimittellehre*, Bd. v. p. 55.

[2] *Essays on the Effects of Carbonate of Iron in Cancer*, Dublin, 1806, p. 396.

[3] *The Nature and Treatment of Cancer*, p. 197, Lond. 1846.

[4] Marc, in Sedillot's *Journal Général de Médecine*, t. xxxiv. and xxxix.

[5] *A Practical Inquiry on Disordered Respiration, distinguishing Convulsive Asthma, its Specific Causes*, &c. Birmingham, 1797.

[6] *Cases of Tic Douloureux successfully treated.* 1820.

[7] *Observations on some of the Parts of Surgical Practice*, Lond. 1847.

where there is a manifest tendency to anæmia, with a pale flabby condition of the solids.

γ. Medicines acting Dynamically on the Blood.

As the living tissues may have their vital properties modified, independently of obvious physical and chemical agencies, by substances which are said to act dynamically (see p. 91), so it may be supposed that the living blood is liable to be affected in a similar way.

The agents which we might expect to act thus on the blood are the vegetable acrids and the substances commonly termed narcotics; for these bodies powerfully affect the vital properties of animals, without, for the most part, exercising any marked physical or chemical influence over the constituents of the living body.

The corpuscles and the fibrin are the organic elements of the blood, in the changes of which we might expect to procure some evidence of the dynamical action above alluded to. Hitherto, however, no conclusive proofs of the existence of this action have been obtained. The changes in the condition of the corpuscles which Schultz regards as vital, are, as I have before stated (see p. 112), clearly physical. The acceleration, retardation, or prevention of the coagulation of the blood, effected by various agents, may be due to physical or chemical as well as to vital changes.[1] Nor can we adduce alterations in the consistency of the plasma as evidence of the dynamical action producing them. In fine, however strong and well-grounded may be our belief in the dynamical action of medicinal and poisonous agents on the blood, conclusive evidence thereof is still wanting.[2]

Class V. *Pneumatica.* Medicines acting on the Respiratory Organs.

Medicines which act as therapeutical agents, by their influence over the functions of respiration and calorification, may be termed *pneumatica* (*πνευματικά*; from *πνέω*, *I breathe*).

Some of them modify the respiratory movements by their influence over the muscles of respiration; some modify the condition of the aërian mucous membrane; some diminish the want of breath; while others influence the function of calorification.

1. *Pneumatica affecting the muscles of respiration.*[3]—These are agents

---

[1] "Mr. Hunter, conceiving coagulation to be an act of life, maintained that the blood coagulates by virtue of its living principle. If we admit this hypothesis, we must also admit that we can pickle the life; that it is preserved after repeated freezing and thawing; and, as Dr. Davy remarks, that the blood may remain alive many hours after the death of the body, when the muscular fibre has lost its irritability, the limbs have stiffened, and even partial decomposition has begun."—(*The Works of William Hewson*, F.R.S., edited by G. Gulliver, F.R.S., foot-note, p. 21, Lond. 1846.)

[2] Dr. C. B. Williams (*Principles of Medicine*, pp. 374 and 385) admits *necræmia*, *νεκρός*, *dead*, and *αἷμα*, (*blood*), or death beginning with the blood, as one mode of death. The causes of this are poisons.

[3] Under the denomination of muscles of respiration I include the contractile fibres of the bronchial tubes. That they are muscular, is shown by their structure, which is that of the unstriped muscular fibres (Todd and Bowman's *Physiological Anatomy*, vol. i. p. 162); as well as by their being excited to contraction by the galvanic stimulus, as proved in Dr. C. J. B. Williams's experiments (*The Pathology and Diagnosis of the Diseases of the Chest*, 4th edit. p. 320, London, 1840): and that they are in some way concerned in respiration can scarcely, I think, be doubted.

which operate directly on the nervous system and indirectly on the muscles of respiration (see *Class* VI. *Neurotica*).

The efficacy of certain narcotics (*e. g.* stramonium and belladonna) in relieving a paroxysm of spasmodic asthma may be ascribed to their power of allaying spasm of the muscular fibres of the bronchial tubes. Dr. C. J. B. Williams found that several substances destroyed the contractility of these fibres. "Extracts of stramonium and belladonna produced this effect most completely. Strychnia, extract of conium, and bimeconate of morphia, also, to a great degree. Hydrocyanic acid, on the other hand, did not impair it at all. The action of these poisons on the bronchial fibres does not correspond with that on other contractile tissues, such as the heart and arteries, œsophagus and intestines, and the voluntary muscles; these in many cases have retained their irritability when that of the bronchi has been destroyed. It is possible that some medicinal agents (strychnia, for example,) may impair the contractility of the bronchial fibres by fixing them in a state of tonic spasm."

2. *Pneumatica affecting the aërian membrane.*—The mucous membrane lining the air passages and lungs is the seat of secretion and exhalation, and of the action of various medicines which will be noticed among the agents operating on the secernent system (see *Class* VIII. *Eccritica*).

3. *Pneumatica diminishing the want of breath.*—These are agents which act as torporifics. They lessen the activity of the functions, retard the oxidizing processes going on in the animal economy, and consequently diminish the want of oxygen in the system.

Sleep and hybernation are physiological states allied to the pathological condition here referred to. In both states the amount of respiration is diminished.

Syncopal asphyxia is another allied condition. On persons in a state of syncope, deprivation of air has not the same injurious effect as on persons whose functions are in full activity.[1]

Under the influence of agents which diminish the want of breath, the combustion of hydrogen, carbon, phosphorus and sulphur in the system must be reduced, and the amount of excreted oxidized products (water, carbonic, phosphoric, and sulphuric acids) lessened. For obvious reasons, however, it is almost impossible to verify this statement experimentally in the case of hydrogen; and with respect to sulphur, I am unacquainted with any experiments made to ascertain the actual amount of this substance consumed in the system.[2] From Dr. Prout's experiments,[3] however, it appears that spirituous liquors and tea lessen the quantity of carbonic acid exhaled: and Dr. Bence Jones[4] has recently ascertained that the amount of phosphoric acid contained in the urine of patients suffering with delirium tremens was diminished in a remarkable degree when no food could be taken; so that it is obvious that the use of alcohol diminishes the consumption of carbon and phosphorus, and that tea has a similar effect with respect to carbon.

It follows, therefore, that if the activity of the combustion processes be reduced, less oxygen will be required, and consequently the necessity for respiration will be diminished. To this is, in some cases, to be ascribed the temporary cessation of dyspnœa obtained by the use of narcotics,[1] and the infrequency or rarity of the respiration in poisoning by opium.[2]

---

[1] See the art. *Asphyxia*, by Dr. Carpenter in *The Library of Medicine*, vol. iii. Lond. 1840.

[2] According to Dr. Ronalds (*Phil. Trans.* for 1846, p. 461) both sulphur and phosphorus are normally excreted by the kidneys in an unoxidized state.

[3] *Annals of Philosophy*, vols. ii. and iv.

[4] *Phil. Trans.* for 1846, p. 449.

The agents which are believed to have this effect of diminishing the want of breath act primarily on the nervous system and secondarily on the respiratory organs. They will, therefore, come under consideration hereafter (see *Class* VI. *Neurotica*).

4. *Pneumatica influencing the calorific functions.*—It can scarcely, I think, be doubted that the ultimate sources of animal heat are the chemical changes going on in the organism; principally the oxidation of carbon, hydrogen, phosphorus, and sulphur. In a general way, therefore, it may be correctly stated, that agents which promote these changes will augment, and those which check them will lessen, the temperature of the body. The former act as calefacients, the latter as refrigerants.

It by no means follows, however, that the heat of the body is directly or immediately derived from these chemical changes. By the oxidation of zinc both heat and electricity are obtained; and these two forces are so correlated that they are mutually convertible the one into the other; or, at least, the one produces the other: thus heat will produce electricity, and conversely electricity produces heat.[3] In like manner, by the oxidation processes going on in the animal body, nervous force and heat are developed;[4] and it appears by no means improbable that a correlation exists between these two forces similar to that which Mr. Grove has shown to exist between the physical forces: the nervous force perhaps may produce heat, and, conversely, heat may excite the nervous force.[5] We know that heat applied to motor nerves produces muscular contractions, and to sensory nerves sensations; and numerous facts may be adduced favouring the notion that the nervous force produces heat. Thus the augmented temperature in the lower parts of the body, sometimes consequent on injuries of the spinal cord, and the flushes or topical extrications of heat frequently observed in nervous and hysterical subjects, favour the notion of the generation of heat by the excitement of the nervous force.

---

[1] See Laennec's *Treatise on the Diseases of the Chest*, 2d edition, translated by John Forbes, M.D. pp. 77 and 99, Lond. 1827. Laennec believed that narcotics diminished the necessity of respiration, and to this effect he refers the temporary cessation of dyspnœa under their use in acute mucous catarrh. "If at this period of relief," he observes, "we explore the respiration by the stethoscope, we find it the same as during the paroxysm,—a proof that the benefit obtained consists simply in the diminution of respiration."

[2] In a case of poisoning by opium to which I was called by the late Mr. Edwin Quekett, the respiration was only once in every four or five minutes. By the persevering use of artificial respiration for many hours the patient (an old lady) recovered.—The condition of the respiration and of the aspect of patients narcotised by opium is very different to that of apoplectic coma. The respiration is infrequent, the expression is that of deep and perfect repose, and, in the more advanced cases, death-like: the face is pale, and the features shrunk. There is a total absence of stertor, of swelling or puffiness of the features, of distended veins, and of blueness. It is the Carus of Sauvages (*Nosologia Methodica*).—The efficacy of artificial respiration is in part referable to its rousing the patient and checking the lethargy, as does the muscular exercise or motion effected by dragging the patient up and down the room.—In the case above mentioned I was struck with the facility with which artificial respiration was effected; the respiratory muscles seemed to respond to the artificial aid, as if they were only waiting for some additional assistance to resume their wonted activity.

[3] See Grove *On the Correlation of Physical Forces*, London, 1846.

[4] Matteucci (*Lectures on the Physical Phenomena of Living Beings*, p. 322) suggests that while heat is developed in the body by the combustion of fatty matters and of the substances into which fecula is transformed, the nervous force may be due to chemical actions which take place during the changes which the neutral azotised substances of the tissues undergo.

[5] See some interesting observations on this subject in the *British and Foreign Medico-Chirurgical Review*, January 1848, p. 233.

I have already alluded to the different methods of promoting or raising the temperature of the body (see p. 14). The medicinal agents which produce this effect, and to which the term *calefacients* is applicable, do so by accelerating the circulation and respiration. They are, therefore, the agents commonly called *stimulants* or *excitants*, and as such will be noticed hereafter (see *Class* VI. *Neurotica*, p. 203).

The methods of cooling the body have also been before adverted to (see p. 27). Two classes of medicinal agents are said to have this effect, viz. those which diminish the force and frequency of the circulation, and to which the name of *sedatives* has been given; and another class of substances, supposed to produce their effect by a chemical agency, and which have been called *refrigerants*. The former will be noticed hereafter (see *Class* VI. *Neurotica*); the latter require to be examined now.

ORDER REFRIGERANTIA. *Refrigerants* or *temperants*.—Medicinal substances which diminish the temperature of the body when preternaturally increased, are denominated *refrigerants* (from *refrigero*, I cool), or *temperants* (from *tempero*, I moderate).

The only agent which in all cases reduces animal heat, is cold used in the form of ice, cold air, cold baths, cold lotions, cold drinks, &c. These abstract heat, and thereby lower the intensity of the vital movements, diminish vascular action, and reduce the calorific functions (see pp. 26-27).

But there are certain medicinal substances which, by continued internal use, appear to allay febrile heat, and usually promote the secretions, though they have no power of diminishing the ordinary or healthy temperature; and to these the term refrigerants is usually applied.

The substances supposed to produce these effects are acids, acidulous fruits and herbs, acid whey, and some salts.

Acida vegetabilia (see p. 174).
Acida mineralia (see p. 174).
Potassæ bitartras (see p. 182).
Potassæ nitras (see p. 182).
Fructus aciduli.
Herbæ acidulæ.
Serum lactis acidum.

Dr. John Murray[1] thought that refrigerants furnished ready-combined oxygen to the system, and in that way prevented so large a quantity of it being consumed in the process of respiration. In support of this hypothesis may be mentioned the observation of Mr. Spalding and Dr. Fyfe,[2] that vegetable diet reduces the consumption of oxygen gas in respiration.

According to this view, pectine (or vegetable jelly), citric, tartaric, and malic acids, should be the most effective alimentary refrigerants, since they contain more oxygen than is requisite to form, with their hydrogen, water (see p. 65).

Refrigerants are employed in febrile complaints to allay thirst and lower preternatural heat. The general effects and uses of the acid refrigerants have been before noticed (see *ante*, pp. 174-178).

---

[1] *A System of Materia Medica and Pharmacy*, 5th ed. vol. i. p. 508, Edinb. 1828.

[2] *Annals of Philosophy*, vol. iv. p. 334, Lond. 1814.

Class VI. *Neurotica.* Medicines acting on the Nervous System.

Medicines which have a specific influence on the nervous system, and thereby modify its functions, are called *neurotica* (νευροτικά; from νεῦρον, *a nerve*).

Some of the agents which exercise a topical chemical influence (see *topica chemica,* p. 160), and which after their absorption effect changes in the condition of the blood (see *hæmatica,* p. 172), act also as neurotics. The antispasmodic and saturnine spanæmics (see p. 190) may be referred to as examples. Alcohol also is a neurotic which acts chemically on the tissues; and hydrocyanic acid probably produces some chemical changes in the blood.

But a very large number of neurotics, including opium, morphia, aconitina, strychnia, &c., have no appreciable chemical influence; and, in the present state of chemical and physiological knowledge, their action on the nervous system cannot be explained by affinity.

Most, if not all, neurotics act locally on the nerves, which they paralyse. "The most obvious case of local paralysis of nerves by a narcotic poison," says Müller,[1] "is the dilatation of the pupil and loss of contractile power of the iris consequent on the application of a drop of solution of extractum belladonnæ. In this instance the poison reaches the iris, and the ciliary nerves which are distributed to it, by imbibition. It is evidently a local effect, and not in the slightest degree the result of absorption into the blood, for the pupil of the other eye is unaffected." Aconitina, opium, morphia, conia, &c. are well-known examples of neurotics which exercise a local action on the nerves.

Müller[2] observes that "the change produced in nerves by the immediate application of a poison to them, causing paralysis, is not preceded nor accompanied by any signs of excitement, such as muscular twitchings. The application to the nerves themselves, in a rabbit, frog, or toad, of a watery solution of opium, of strychnine, or of spirituous extract of nux vomica, has, in my experiments, never excited muscular contractions; and I doubt if a narcotic applied directly to a nerve ever excites contractions of muscles: it must, I believe, act through the medium of the spinal marrow and brain."

Some of the neurotics act topically as acrids (see p. 168). The *acro-narcotics* (*e. g.* belladonna and stramonium) and *narcotico-acrids* (*e. g.* colchicum and helleborus) of toxicological writers are of this kind.

The general or remote effects of neurotics are produced not by the extension of the local narcotic effects, but by the passage of the neurotic into the blood, and by the action of the blood, thus impregnated with the deleterious substance, on the central organs of the nervous system and on distant nerves. The tingling and numbness produced in the nerves of the extremities after the introduction of full doses of aconite into the stomach, probably arise from the action of the absorbed aconitina on the nerves of these parts; for the phenomena are analogous to those caused by the topical application of aconite to the nerves.

---

[1] *Elements of Physiology,* translated by W. Baly, M.D., vol. i. p. 630, Lond. 1838.

[2] *Op. cit.* vol. i. p. 626.

The neurotica may be conveniently arranged in two sub-classes; one, called *cerebro-spinalia,* including agents which affect the nervous system of animal life; the other, termed *ganglionica,* comprehending agents affecting the nervous system of organic life.

Sub-class 1. *Cerebro-Spinalia.* Cerebro-Spinals.

This sub-class includes those neurotics which exercise a special influence over one or more of the functions of the brain and spinal cord, and their respective nerves. Those which act on the brain and cerebral nerves may be termed *cerebrals* (*cerebralia*), and such as affect the spinal cord and spinal nerves may be called *spinals* (*spinalia*). But inasmuch as all the cerebrals have some spinal influence, and, conversely, all the spinals some cerebral influence, it is more convenient and correct to include both in one group under the denomination of *cerebro-spinals* (*cerebro-spinalia*).[1]

This sub-class includes the various agents denominated by authors *stupefacientia, narcotica, hypnotica, anodyna, paregorica, inebriantia, exhilarantia, convulsiva,* and *tetanica.*

A considerable number of cerebro-spinalia are either *organic alkalies,* or owe their activity to these substances: for example, morphia, strychnia, brucia, conia, aconitina, veratria, atropia, nicotina, and the plants in which they are found.

Hydrocyanic acid is an active principle, to which laurel-water and oil of bitter almonds owe their activity.

Volatile oil is another active principle. Camphor, oil of hops, cantharidin, and the substances in which these agents exist, are examples.

Alcohol, ether, chloroform, protoxide of nitrogen, and certain *metallic salts,* are themselves peculiar and powerful neurotic principles.

The cerebro-spinalia produce or prevent sleep, or affect one or more of the functions of the brain and spinal cord, and their respective nerves. These functions are the mind, sensation, and the voluntary and reflex-spinal motions. Although there is no cerebro-spinal agent which exclusively limits its influence to one function, yet, as we employ particular cerebro-spinals for affecting particular functions, we may conveniently arrange the substances composing this sub-class in four orders, as follows:—

1. Cerebro-spinals affecting the mental faculties (*phrenica*).
2. Cerebro-spinals affecting sensation (*æsthetica*).
3. Cerebro-spinals affecting the voluntary or reflex-spinal motions (*cinetica*).
4. Cerebro-spinals affecting sleep (*hypnica*).

ORDER 1. PHRENICA (*φρενικά*; from *φρήν, the mind*). *Phrenics.*—Medicines affecting the mental faculties.

---

[1] In the first two editions of this work I called these agents *cerebro-spinants* (*cerebro-spinantia*), a term which Oesterlen (*Handbuch d. Heilmittellehre,* 1845, 2te Aufl. 1847) has adopted without acknowledgment. In deference to the opinions of others, I have now substituted the more classical name of cerebro-spinalia.

The following substances are employed as phrenics :—

VEGETABLE.

PAPAVERACEÆ.
  Papaver somniferum — *Capsulæ, Opium, Morphia.*
SOLANACEÆ.
  Atropa Belladonna—*Folia, Atropia.*
  Datura Stramonium—*Folia, Semina.*
  Hyoscyamus niger—*Folia.*
  Nicotiana Tabacum—*Folia.*

LAURACEÆ.
  Camphora officinarum—*Camphora.*

URTICACEÆ.
  Cannabis sativa, *var.* Indica — *Folia, Resina.*

Alcohol. | Vina. | Ætherea.

Phrenics produce different effects on the mind, and receive different denominations according to the nature of their effect.

a. When they exalt or excite the mind, enliven or exhilarate, they are termed *exhilarants* (*exhilarantia*).
β. When they confuse the intellect and produce delirium, inebriation or phantasms, they are called ***inebriants*** (***inebriantia, phantastica***).
γ. When they stupefy the mind they are denominated ***stupefacients*** or ***narcotics*** (*stupefacientia*, ***narcotica***, ναρκωτικά).

These different effects depend partly on the nature of the phrenic employed, but chiefly on the quantity administered, and on the individuality and the habit of the patient. Wine, for example, taken moderately, exhilarates; in larger quantity, inebriates; and, in excessive quantity, stupifies. In one individual "excitement predominates; in another, stupefaction; nay, what is only a stimulant to one, is a narcotic poison to another. The opium-eaters, in the East, furnish examples of all these varieties."[1]

The substances in popular and medical use for affecting the mental faculties may be arranged in six groups, as follows :—

1. METHYSTICA (μεθυστικά; from μέθυ, *wine*). *Spirituosa* (*alcoholica*); *vina; ætherea; chloroform.*—The employment of wine and ardent spirit for the purpose of exhilaration and inebriation is familiar to every one. The ethers produce a similar but more rapid and temporary effect; and I have known intoxication produced by swallowing chloroform. The ethers and chloroform are procured from alcohol, which, as is well known, is obtained by distillation from vinous liquids.

In the effects of the methystica three degrees may be distinguished. The *first* is that of exhilaration or excitement. This is best seen when the quantity is small. When the dose is larger this degree constitutes the first stage of operation. Volition and intellect are excited, but not otherwise disordered. The *second* degree or stage is that of inebriation, in which both the mental faculties and volition are disturbed as well as excited. There is more or less confusion of intellect or delirium, varying in intensity and character in different individuals. Volition is impaired; there is vertigo, thick speech, and inability to stand or walk: the individual reels or falls about when he attempts to walk. As yet sensation exists, though lessened; sensibility to painful and other impressions being diminished. The *third* degree is unconsciousness or stupefaction.

---

[1] Feuchtersleben's *Principles of Medical Psychology*, p. 168, 1847.

The individual is now insensible, or nearly so, though sometimes capable of being roused when loudly spoken to.

Convulsions are not common: when they do occur it is usually in young subjects. The breath is impregnated with the vapour of the liquid swallowed. The pupils are generally dilated, sometimes (in the worst cases) motionless; occasionally, especially in fatal cases, contracted. In the stage of stupor the breathing is for the most part slow and soft, yet not unfrequently laborious; rarely stertorous.

Delirium tremens is a brain affection, which may be regarded as an effect of chronic poisoning by alcohol. It combines wakefulness, delirium, and tremor. The delirium is of a peculiar character: it consists in the imagined presence of objects (phantasms), such as cats, rats, and mice, which are supposed to be moving, and which the patient is anxious to seize or to avoid. The amount of phosphates in the urine is remarkably diminished in this disease.[1]

Considered with reference to the state of the mind only, the methystica are employed as exhilarants in mental depression, and as excitants in delirium from exhaustion.

2. MECONICA (*μηκωνικά*; from *μήκων*, *a poppy*.) *Papaveracea*; *Opiata*. —*Papaver somniferum*; *opium*; *morphia*.

The meconica check the secretions of the bronchial and gastro-intestinal mucous membranes, promote sweating, produce contraction of the iris, relieve pain and spasm, cause sleep, and, in large doses, give rise to the state called *narcotism*, in which the sleep is deep, and the respiration tranquil but infrequent (see *ante*, p. 201, footnote).

Two degrees or stages of their effects may be admitted, viz. excitement and sleep or stupor. The predominance of the one or the other depends on circumstances before adverted to (see *ante*, p. 205).

The general effects on the mental functions, for the production of which opium is chewed and smoked by Eastern nations, are tranquillity and serenity of mind, freedom from bodily and mental uneasiness, a feeling of comfort and happiness, animation and exhilaration. The deleterious effects on the bodily functions of opium-eating and opium-smoking will be described hereafter.

The meconica are employed to render persons capable of undergoing great mental exertion and bodily fatigue, and to beneficially modify the condition of the intellectual functions in delirium tremens and in some forms of insanity. These uses will be more fully noticed hereafter.

3. CANNABINA (*καννάβινα*; from *καννᾶβις*, *hemp*.) *Cannabis indica*; *churrus*; *gunjah*; *bang*, *subjee*, or *sidhee*; *majoon*; *hashisch*.

The cannabina, according to Dr. O'Shaughnessy,[2] cause a very agreeable kind of delirium or *fantasia*, augmented appetite, venereal excitement, and impaired volition, followed by insensibility, during which the patient retains any position in which he may be placed. This effect simulates catalepsy. I have found Indian hemp to act as an anodyne, antispasmodic, and soporific. In some cases the pupils seemed unaffected, in others were dilated.

Dr. O'Shaughnessy describes a singular form of insanity occasioned by the incautious use of hemp, and which is as singular as the delirium tremens brought on by the prolonged abuse of spirituous liquors. It is at once "recognised by the strange balancing gait of the patient, a constant rubbing of the hands, perpetual giggling, and a propensity to caress and chafe the feet of all by-standers, of whatever rank. The eye wears an expression of cunning and merriment which can scarcely be mistaken. In a few cases, the patients are violent; in many, highly aphrodisiac; in all that we have seen, voraciously hungry: there is no increased heat or frequency of circulation, nor any appearance of inflammation or congestion, and the skin and general functions are in a natural state."

---

[1] Dr. Bence Jones, *Phil. Trans.* 1846.

[2] *On the Preparations of the Indian Hemp, or Gunjah* (*Cannabis Indica*), *their Effects on the Animal System in Health, and their Utility in the Treatment of Tetanus and other Convulsive Disorders.* By W. B. O'Shaughnessy, M.D. Calcutta, 1839.

In India, Caubul, Syria, Northern Africa, and other parts of the world, the cannabina are used for the purpose of intoxication. They are both swallowed and smoked.[1]

4. CAMPHORACEA. *Camphora officinarum; camphora.*

Camphor is a popular favourite with some nervous and hysterical famales on account of its agreeable effects on "the nerves." Large doses of it occasion confusion of intellect, delirium, impaired volition, convulsions, and insensibility. It is anaphrodisiac.

It has been used to calm the violence of maniacal patients, and to allay excitement of the sexual feelings in nymphomania. In insensibility or profound coma, camphor, in the form of enema, has been found by Dr. Copland[2] highly serviceable by rousing the patient.

5. NICOTIANÆ. *Tobaccos. Nicotiana tabacum*; *N. repanda*; *N. rustica*; *N. persica.*

Several species of *nicotiana* are used for smoking and for yielding snuff. They agree in the general character of their effects, but differ in their strength. *Lobelia inflata* (called Indian tobacco) closely resembles the nicotianæ in its effects.

Tobacco is smoked and chewed on account of its calming and tranquillising influence on the nervous system. "The soothing and flattering visions, with which the practice of smoking feasts the weak and effeminate mind, lead to its adoption by most classes; but it is an enervating and an emasculating luxury."[3]

Tobacco acts as a nauseating, cardiaco-vascular sedative. It occasions vomiting, purging, weakness and irregularity of pulse, syncope, impaired vision, contracted pupil, giddiness, and confusion of ideas. Paralysis, convulsions, delirium, and stupor, are occasional symptoms.

As a calming, soothing, and hypnotic remedy, smoking is sometimes useful (for those accustomed to the practice) in mental excitement and wakefulness.

6. SOLANACEA MYDRIATICA (*mydriatica*, from *μυδρίασις*, *dilatation of the pupil*; solanaceous substances causing dilatation of the pupil; *phantasmatica*, from *φάντασμα*, *a phantom*; agents creating phantasms: *phantastica*). *Atropa belladonna*; *datura stramonium*; and *hyoscyamus niger.*

These agents produce dilatation of pupil (see p. 203), long-sightedness (presbyopia), great dryness of throat, cheerful delirium, with phantasms, followed by stupor. The eyes are usually blood-shot. Convulsions are not constant.

---

[1] For a very interesting account of the effects of Indian Hemp, see Dr. Morean's work entitled *Du Hachis et de l'Aliénation Mentale, Etudes Psychologiques*; Paris, 1845. Reviewed in Forbes's *Brit. and Foreign Medical Review*, vol. xxiii. 1847.

[2] *Dictionary of Practical Medicine*, vol. iii. p. 370.

[3] *Op. supra cit.* vol. iii. p. 404.

The obscurity of vision or blindness produced by these agents is referable chiefly, if not entirely, to the alteration in the refractive action of the eye (see p. 217), by which presbyopia is induced; for it is greatly relieved by the use of magnifying glasses. The difficulty of deglutition depends principally on the extreme dryness of the throat; and hence it is partially relieved by taking water with each mouthful. The hoarse voice or aphonia probably arises from the same cause, for it also is relieved by drinking water.

A scarlet eruption occurs in poisoning by belladonna. Both belladonna and stramonium are acro-narcotics. They produce dilated pupil by topical application (see p. 203).

Hyoscyamus is used as a calming, soothing, and tranquillising agent in nervous excitability and mania. Belladonna and stramonium are rarely employed for their mental influence. Their other uses will be noticed hereafter.

ORDER 2. ÆSTHETICA (αἰσθητικά; from αἴσθησις, *sensation*). Agents affecting sensation.

As the term *æsthetica* applies to any or all of the senses, it is necessary to qualify it when we apply it to any particular sense. Agents which affect any of the senses may, therefore, be called *æsthetica communia;* those affecting sight, *æ. optica;* those affecting hearing, *æ. acoustica;* those affecting smell, *æ. osmetica;* those affecting taste, *æ. geustica;* and, lastly, those affecting common sensibility or touch, *æ. haptica.*

Æsthetics are employed in medicine either to heighten sensibility or to lessen it: in the former case they may be termed *hyperæsthetica*; in the latter, *anæsthetica.*

SUR-ORDER 1. HYPERÆSTHETICA (ὑπεραισθητικά; from ὑπέρ, *above* or *over*, and αἰσθητικά). Agents which render sensation more acute.—*Strychnos nux vomica*; *strychnia*; *brucia*; *rhus toxicodendron* (?).

Nux vomica, strychnia, and brucia, heighten the sensations of touch, vision, and hearing, and give rise to various unpleasant or painful sensations in different parts of the body, especially in paralysed parts. Toxicodendron also is said to have produced a return of sensibility, with a feeling of burning and pricking in paralysed parts.

These agents have been employed to excite the sensibility of paralysed parts.

SUB-ORDER 2. ANÆSTHETICA (ἀναισθητικά; from α *non*, and αἰσθητικά). *Narcotica* (ναρκωτικά, from νάρκωσις, *a benumbing*); *anodyna* (ἀνώδυνα, from α *non*, and ὀδύνη, *pain*); *paregorica* (παρηγορικά, from παρηγορέω, *I soothe* or *appease*). Agents which diminish sensibility or relieve pain. The term anæsthetica is commonly applied to agents which diminish common sensibility or sensibility to pain.

This sub-order includes a considerable number of agents, viz. the *methystica*, *meconica*, *cannabina*, and *solanacea mydriatica* before mentioned (see pp. 205, et seq.), to which must be added *aconitum napellus*, *aconitina*, *veratria*, *nitrogenii protoxydum*, *hydrocyanic acid*, and the substances containing it, and the *alkaline cyanides*. These agents considered as anæsthetics may be arranged in two divisions, as follows:—

1. Vapours or gases which, when inhaled, temporarily suspend the common or general sensibility of the body; in other words, produce insensibility, and are thereby fitted for preventing pain during surgical operations and parturition, are the anæsthetics commonly so called. I shall term them the *anæs-*

thetica pneumatica (πνευμᾱτικά; from πνέω, *I breathe*), to distinguish them from other anæsthetic agents.

Those in common use are the vapours of *chloroform* and *ether* (sulphuric ether).

Protoxide of nitrogen and the vapours of *hydrochloric* and *nitric ethers*, of *benzine*, and of *bisulphuret of carbon*, are said to produce similar effects.

By inhalation these vapours are absorbed into the blood. This is proved by the detection of them in different parts of the body (even in amputated limbs), and by their continued exhalation by the breath for some time after the individual has ceased to inhale them.

The blood thus holding in solution the vapour of the anæthestic agent, acts on the nervous centres, and disturbs or suspends, or even destroys, their functions.

All the functions of the nervous centres are not simultaneously, but successively and progressively, affected. The intellect or mind, and volition or the power of regulating locomotion, are first lost; then sensation and motion; and lastly the power of respiration. The action of certain parts supplied by the ganglionic system of nerves, as the heart and intestines, continues for some time after the death of the individual.

Flourens[1] thus describes the successive and progressive action of ether on the nervous centres:—First the cerebral lobes lose their power, viz. the intellect; next the cerebellum loses its, viz. the power of regulating locomotion; afterwards the spinal marrow loses the principle of sensation and motion; and lastly, the medulla oblongata loses its power, viz. the motor principle of respiration; and with this, life is lost.

The effects produced by the inhalation of these agents may be conveniently arranged in three stages: the first stage is that in which the mind is clear, though the feelings are somewhat altered, and volition is exercised. The second stage is that of inebriation, in which both the mental faculties and volition are impaired, but in which consciousness still remains. The third stage is that of unconsciousness or insensibility, or dead drunkenness. Of this third stage there are three degrees:—In the first or mildest, the respiration exists; and muscular twitches, involuntary movements or rigidity of the muscles, and groans and cries, sometimes occur; but no articulate sounds: in one case (that of a man) operated on under the influence of chloroform, at the London Hospital, an imperfect and slight attack of opisthotonos took place. In the second degree, the insensibility is complete, but no movements, except those of respiration, are observed; the breathing is often attended with snoring, and occasionally with stertor; the iris is fixed; and the orbicularis palpebrarum does not contract when touched. In the third degree, the respiration is paralysed, and death occurs.

In a fatal case from the inhalation of chloroform, after insensibility had been induced, the patient (a girl, aged 15,) gave a kick or twitch at the termination of the incision; her lips, which had been previously of good colour, became suddenly blanched, and she spluttered as if in epilesy. No rally took place, and, within two minutes from the commencement of inhalation, the patient was a corpse.[2]

---

[1] *Comptes rendus*, t. xxiv. No. 8, Feb. 22, 1847.

London Medical Gazette, Feb. 11, 1848.

There is diminished sensibility to pain during the second stage. Complete insensibility to pain exists during the third stage: in some cases it is also found in the second stage. Unconsciousness, therefore, is not absolutely essential to the anæsthetic effect.[1]

When patients are recovering from the state of insensibility, the inhalation having been discontinued, it often happens that they acquire consciousness, vision, hearing, and the power of speech, without becoming sensible to the pain of an operation.

Every one is now familiar with the application of these anæsthetics for the prevention of pain during surgical operations and parturition. They have also been used with much success in other cases as anodynes, antispasmodics, and soporifics.

2. The second division of anæsthetics consists of solid and liquid agents which when swallowed, injected into the rectum, or applied to the skin, alleviate pain. It includes, therefore, all those substances to which the term *anodyne* has hitherto been usually applied. The agents belonging to this division may be arranged in three groups as follows:—

α. Some of these agents, when applied to the skin or lips, occasion numbness of the part, along with tingling and pricking, somewhat analogous to the feeling which is experienced when sensation is returning to a part which has been "asleep," after the removal of pressure upon a nerve, and which is commonly called "pins and needles." Such agents may be denominated *nerve-benumbers.* The topical effect which they produce is allied to that occasioned by some acrids; but is devoid of the sensation of heat.

Aconitum napellus, aconitina, and *veratria,* produce the effects just described.

Tincture of aconite, when taken internally in small doses, produces, especially in hysterical females, tingling, numbness, and various anomalous sensations in different parts of the body. These remote effects probably depend on the topical action of the active principle of the aconite on the nerves through the medium of the blood (see p. 203).

The benumbers are adapted for the relief of neuralgia.

β. Some anæsthetics produce no perceptible alteration in the normal feeling of the parts to which they are applied, though, when taken internally, they become absorbed, and relieve pain. Their anodyne effect seems referable to their influence over the nervous centres, on which they act as stupefacients. These are the agents to which the term *anodyne* is usually applied. This group includes the *meconica, methystica, cannabina,* and *solanacea mydriatica.* Of these, ether, opium, and morphia, are by far the most certain and effective anodynes for relieving acute pain of internal organs. They are most successful in alleviating spasmodic pain (see *ante,* pp. 206, 207).

γ. Another group of agents used for relieving certain kinds of pain includes *hydrocyanic acid,* and substances containing this acid (as *volatile oil of*

---

[1] Dr. Snow (*Lancet*, Feb. 12, 1848,) thinks, that in all cases in which patients feel no pain during surgical operations, previous unconsciousness must have existed. I believe this to be an error. An Irishman had his leg amputated, at the London Hospital, under the influence of ether, without experiencing pain; and the sly winks and facetious nods during the inhalations, and the humorous observations made in the intervals, left no doubt in the mind of every person present of his consciousness during the whole period. An imperfect report of the case appeared in the *Times*, and was copied into the *London Medical Gazette*, Jan. 12, 1847. This patient was a spirit-drinker.

bitter almonds, *cherry-laurel water*, &c.), *arsenic*, *trisnitrate of bismuth*, the *ferruginea*, and *disulphate of quina*.

These agents relieve only certain kinds of pain, such as that commonly known as neuralgic; and not always this. They do not act either as benumbers or stupefacients.

Hydrocyanic acid has a very slight benumbing effect on the nerves of common sensation; and, in large doses, occasions sudden loss of intellect, sensation, and volition, usually with convulsions.

In many cases, if not in all, the pain which they relieve is produced by reflection or sympathy. This reflection of impressions which produce sensation is effected by the nervous (probably the spinal) centre.

The agents above enumerated as relieving neuralgia probably do so by their influence on the nervous centre. Hydrocyanic acid is well known to depress the reflex motor functions of the spinal cord, and it is not unlikely, therefore, that it does the same with the reflex sensory functions. The metallic salts, above mentioned as being useful in neuralgia, are valuable agents in relieving certain disorders referable to the reflex motor functions of the cord, such as chorea (see *ante*, pp. 195 and 197).

This group of anæsthetica is applicable to neuralgia in general; but is more particularly serviceable in the neuralgia of certain parts, as of the face (tic douloureux), of the stomach (gastrodynia), and of the bowels (enterodynia).

ORDER 3. CINETICA (*κινητικά*; from *κίνησις*, *motion*). Agents affecting the voluntary and reflex-spinal movements.

The cinetica may be considered under four heads, according as they affect the tonicity or the irritability of muscles, the exercise of volition, or reflex-spinal action.

a. Cinetica affecting the tonicity of muscles.—Muscular, as well as some non-muscular, parts possess the property called *tonicity* or *tone*, sometimes termed ***retractility***. It is a tendency to passive or slow and moderate contraction not necessarily alternating with relaxation. It is augmented by cold and impaired by heat. It is greatly influenced by, if it be not absolutely dependent on, the cerebro-spinal system.[1]

Pharmaceutical agents which augment the tonicity are called *tonics*, while those which lessen it are denominated *relaxants*.

SUB-ORDER *a*. TONICA (*τονικά*; from *τόνος*, *tone*). *Corroborantia* seu *roborantia*; *euplastica*. Agents which increase the tone of the system.

Dr. Billing[2] gives the following definition of tonics:—"Tonics are substances which neither immediately nor sensibly call forth actions like stimulants, nor depress them like sedatives, but give power to the nervous system to generate or secrete the nervous influence by which the whole frame is strengthened."

The action of a tonic must not be confounded with that of a stimulant. Tonics give strength, stimulants call it forth. Stimulants excite action; but action is not strength: on the contrary, over-action increases exhaustion.[3]

---

[1] See Dr. M. Hall *On the Diseases and Derangements of the Nervous System*, p. 78.

[2] *First Principles of Medicine*, p. 92, 4th edit. 1841.

[3] *Ibid.* p. 95.

The following is a list of the substances to which the term tonic is usually applied:—

1. VEGETABLE.

- MENISPERMACEÆ.
  - Cocculus palmatus—*Radix calumbæ.*
- POLYGALACEÆ.
  - Krameria triandra—*Radix rhataniæ.*
- AURANTIACEÆ.
  - Citrus Limonum—*Cortex fructûs.*
  - Citrus vulgaris—*Cortex fructûs.*
- RUTACEÆ.
  - Galipea officinalis—*Cortex cuspariæ.*
- SIMARUBACEÆ.
  - Simaruba amara—*Cortex radicis.*
  - Picræna excelsa—*Lignum.*
- LEGUMINOSÆ.
  - Hæmatoxylon campechianum—*Lignum.*
  - Acacia Catechu—*Extractum.*
  - Pterocarpus marsupium—*Extractum* (*kino*).
- ROSACEÆ.
  - Rosa gallica—*Petala.*
  - Potentilla Tormentilla—*Radix.*
  - Geum urbanum—*Radix.*
- GRANATÆ.
  - Punica granatum—*Cortex fructûs.*
- LYTHRACEÆ.
  - Lythrum Salicaria—*Radix.*
- STELLATÆ.
  - Rubia tinctorum—*Radix.*
- CINCHONACEÆ.
  - Cinchona: plurimæ species—*Cortex, Quina, Cinchonia.*
  - Uncaria Gambir — *Extractum* (*Gambir*; *Catechu*).
- COMPOSITÆ.
  - Taraxacum Dens-leonis—*Radix.*
  - Tanacetum vulgare—*Herba.*
  - Artemisia Absinthium—*Herba.*
  - Anthemis nobilis—*Flores.*
  - Inula Helenium—*Radix.*
- ERICACEÆ.
  - Arctostaphylos Uvæ-ursi—*Folia.*
- APOCYNACEÆ.
  - Strychnos Nux vomica—*Semina; strychnia; brucia.*
- GENTIANACEÆ.
  - Gentiana lutea—*Radix.*
  - Agathotes Chirayta—*Herba.*
  - Erythræa Centaurium—*Summitates.*
  - Menyanthes trifoliata—*Herba.*
- POLYGONACEÆ.
  - Rheum—*Radix.*
  - Polygonum Bistorta—*Radix.*
  - Rumex aquaticus—*Radix.*
- LAURACEÆ.
  - Nectandra Rodiei—*Cortex, bebeerine.*
- EUPHORBIACEÆ.
  - Croton Cascarilla—*Cortex.*
- URTICACEÆ.
  - Humulus Lupulus—*Strobili.*
- ULMACEÆ.
  - Ulmus campestris—*Cortex.*
- CUPULIFERÆ.
  - Quercus pedunculata—*Cortex.*
  - Quercus infectoria—*Gallæ; acidum tannicum; acidum gallicum.*
- SALICACEÆ.
  - Salix: plurimæ species—*Cortex, Salicin.*
- SMILACEÆ.
  - Smilax: plurimæ species—*Radix.*
- ACORACEÆ.
  - Acorus Calamus—*Rhizoma.*
- LICHENACEÆ.
  - Cetraria Islandica.

2. ANIMAL.

Bos taurus—*Fel.*

3. INORGANIC.

Acida mineralia (see *ante*, p. 174).
Alumen (see *ante*, pp. 162 and 182).
Ferruginea (see *ante*, pp. 162 and 193).

Argenti nitras
Bismuthi trisnitras
Cupri sulphas
Zinci sulphas
Zinci acetas
(see *ante*, pp. 162, 189, 212, and 219).

Besides the preceding, various other substances are by some writers denominated tonics.

"The term tonic," says Dr. Billing, "is applicable to all those medicines which cure chronic inflammation without being either stimulant, or directly sedative or depletory." As mercury cures inflammation, both when stimulants are carefully withheld as well as when they are necessarily administered, he considers this metal to be "neither stimulant nor sedative, but tonic; that is, by its specific action on the capillaries, whether directly on their issue, or through the medium of their nerves, it causes them to contract when (though all the injecting force of the heart were taken off by sedative treatment) they would not have had power to close; for, when introduced into the system, it circulates to the capillaries, and gives them tone to contract, analogous to the effect of an astringent applied to external sores. Liquor arsenicalis, nitrate of silver, the sulphates of copper and iron, mezereon, dulcamara, colchicum, &c., have a similar action, some of which are more available than others in particular cases." "Even narcotics frequently become, in an indirect manner, most usefully tonic."

The active principles of the tonics are of five kinds:—

1. *Vegetable alkaloids*, as quina, cinchonia, bebeerine, strychnia, brucia, &c.

2. *Vegetable crystallizable but indifferent principles*, as salicin, cascarillin, gentianin, &c.

3. *Vegetable acids*, as tannic, gallic, chrysophanic, &c. acids.

4. *Animal matter*, bile.

5. *Inorganic substances.* Certain metals, as iron, arsenic, silver, copper, zinc, bismuth, and aluminum, form compounds which are used as tonics. Some of the mineral acids, as the sulphuric, nitric, and hydrochloric, are employed as tonics.

Some of the vegetable tonics are said to owe their bitterness and medicinal activity to a principle to which the terms *materia hermaphrodita*, *materia saponacea*, and *extractive matter*, have been applied. It is described as being of a brown colour, soluble in water and alcohol, insoluble in ether, and becoming insoluble in water by long-continued boiling and by exposure to light and air.

That a substance, or mixture of substances, possessed of these properties may be obtained from various plants cannot be doubted, but it is not probable that chemists have yet succeeded in obtaining a proximate principle to which the term extractive can with propriety be applied. What has hitherto been procured is a mixture or compound of several principles, such as vegetable acids and their combinations with potash and lime, colouring matter, sugar, gum (rendered soluble in alcohol by its combination with other substances), vegetable bases, &c.

The topical effects of the tonics, considered as a class, are not very considerable. Those which contain tannic acid, as well as the mineral astringents, act chemically on the tissues to which they are applied (see *ante*, pp. 98 and 162).

The tonic principles, when taken into the stomach, form, in most cases, new chemical combinations; then become absorbed, and are afterwards thrown out of the system by the excreting organs. Some of them (*e. g.* quina and chrysophanic acid [colouring matter of rhubarb]) have been detected in the blood; some (*e. g.* tannic, gallic, and chrysophanic acids, and quina) have been found in the urine; some (*e. g.* quina) in the milk; and some (*e. g.* chrysophanic acid) in the cutaneous transpiration (see *ante*, pp. 105 and 106), The changes which the mineral substances used as tonics suffer, and the evidences of their absorption and subsequent excretion, have been before adverted to (see *Spanæmica*, p. 173, and *Hæmatinica*, p. 193).

The agents called tonics only act as such in certain states of disease. Under other conditions they act as irritants or stimulants, or even as sedatives.

In the healthy state moderate doses produce no sensible effects, or perhaps a slight excitement of the appetite merely, while large quantities give rise to nausea and vomiting. They may then act as sedatives by nauseating. In irritation or inflammation of the stomach and intestines, and in febrile conditions of system, attended with a hot and dry skin, and a furred and dry tongue, tonics act as local irritants and stimulants, and add to the severity of all the morbid symptoms.

Tonics sometimes purge, at others constipate. When diarrhœa arises from, or is kept up by, a weakened state of the intestinal tube, tonics, by restoring strength, may produce constipation. On the other hand, when constipation depends on a debilitated and torpid condition of this tube—a circumstance not uncommon in females—tonics not unfrequently occasion alvine evacuations. Dr. Cullen, having noticed how frequently bitters act as laxatives and purgatives, has inserted them in his list of cathartics.

Tonics are closely related to stimulants; and, on many occasions, the so-called tonic substances act really as stimulants. Thus, in weak but irritable subjects recovering from a protracted state of fever, disulphate of quina will frequently act both as a local irritant and stimulant, and produce nausea, vomiting, furred tongue, a febrile state of system, headache, &c.

Some of the agents employed as tonics produce, when taken in large doses, convulsive movements, or even a tetanic state, giddiness, delirium, &c.

Tonics are employed where the tonicity of the system is defective; that is, in cases of atony or debility, with a soft, flaccid, and loose condition of the soft solids. Properly administered in these cases, their true tonic operation is then observed. Their immediate effects are to increase the appetite and assist digestion. After they have been administered for some time, the soft solids (as the muscles, cellular tissue, &c.) become firmer, the muscular strength greater, and the pulse stronger, though not quicker. In fact, all the functions are performed with more energy, and the patient is capable of greater exertion.

Tonics are remarkable for their peculiar and powerful curative agency in certain diseases whose pathology is very obscure. I refer now to the cure of ague by arsenic and quina; of chorea by arsenic and iron; of neuralgia by arsenic, quina, and iron; and of epilepsy by arsenic, silver, and zinc (see pp. 190, 197, 198, and 211). These effects prove the action of tonics on the central organs of the nervous system.

This order may be arranged in three sections, as follows:—

1. ASTRINGENTIA VEGETABILIA PURA.—Pure vegetable astringents. This section comprehends those vegetable tonics which possess considerable astringency with little or no bitterness;[1] such as tannic and gallic acids, oak-bark, nut-galls, uva-ursi, catechu, logwood, rhatany, tormentilla, pomegranate-rind, bistort, and kino. These agents are principally remarkable for causing local contraction and corrugation (or astriction) of the tissues. They contract and give greater density to the muscular fibres, diminish the calibre of the blood-vessels and exhalants, and thereby check hemorrhage (whence their denomination of *styptics*), and diminish secretion and exhalation when applied to mucous membranes or other secreting surfaces. In the mouth they give rise to a peculiar sensation of roughness and stypticity. These effects have been ascribed to a chemical or physical agency. Thus Dr. Cullen places astringents among substances acting on the simple solids, though, in another part of his treatise, he admits that they act on the living as well as on the simple solids. The late Dr. Adair Crawford[2] ascribed the effects of both astringents and bitters to their influence in promoting the cohesion of the animal fibre. He immersed some pieces of intestines, of skin, &c. in various bitter and astringent infusions, while others were placed in water, merely as a standard;

---

[1] For some observations on the distinction between astringency and bitterness, see Perceval' *Essays*, vol. i. 2d edit. Lond. 1772.

[2] *An Experimental Inquiry into the Effects of Tonics, &c.* 1816.

and he then observed the comparative weights required to break them, from which he inferred the relative strength of different tonics. But this mode of reasoning naturally leads to erroneous inferences, since the vital powers of the system are quite overlooked. The relaxed state of parts, which astringents are useful in obviating, depends not on a mere mechanical or chemical alteration, but on some change in the state of vital powers; and, therefore, the agents which counteract it must have some other than a mere physical or chemical action. Moreover, the results obtained by Dr. Crawford depended probably on the different degrees of antiseptic power possessed by the substances employed, Astringents produce the constitutional effects of the bitter tonics: administered in moderate doses, they promote the appetite, assist digestion, and increase the tone and vigour of the general system. They are capable of fulfilling the same therapeutic indications as the bitter tonics. Thus, they have the power of preventing the occurrence of a paroxysm of intermittent fever; and in cases of debility are often useful, independently of their power of checking debilitating discharges. But this group is principally employed for its local effects, to obviate relaxation of fibres and tissues, and to prevent or check excessive discharges.

2. AMARA.—Bitter tonics. These are characterised by bitterness. They may be arranged in five sections, as follows:—

α. *Amara pura seu simplicia.*—Simple or pure bitters. This group includes those vegetable tonics which possess bitterness with little or no astringency or aroma. To this division are referred quassia, simaruba, gentian, chirayta, common centaury, and menyanthes. To these must be added, the vegetable alkaloids and the crystallizable indifferent principles before mentioned. These remedies are employed to promote the appetite and assist digestion in atonic and enfeebled conditions of the stomach; as general tonics in feebleness and debility of the whole system, and especially of the muscles; as antiperiodics in intermittent diseases; and as anthelmintics. Their beneficial operation in expelling intestinal worms has been referred to their poisonous influence over these parasitical animals, but ought perhaps rather to be ascribed to their improvement of the condition of the alimentary canal, and to the removal of those states which favour the production of these beings. The power which they possess of retarding the acetous fermentation may, perhaps, contribute to their beneficial operation in some dyspeptic cases accompanied with acidity and flatulence.

β. *Amara mucilaginosa.*—Mucilaginous or demulcent tonics, which contain, besides a bitter principle, mucilage or starchy matter, but little or no aroma or astringency. This section includes calumba, and Iceland moss. In addition to the properties of the simple bitters, they possess demulcent and slightly nutritive properties, which they owe to the presence of starch.

γ. *Amara aromatica seu excitantia.*—Aromatic bitters, which possess bitterness, with an aromatic flavour (derived from the presence of volatile oil), but little or no astringency. This group contains wormwood and elecampane, cascarilla, angustura-bark, orange and lemon peel, and hops. These substances possess the combined properties of aromatics and bitter tonics, and are, therefore, useful where these are indicated.

δ. *Amara resolventia seu laxativa.*—Resolvent or laxative bitters. To this section are referred taraxacum, rhubarb, aloes, and extract of ox bile. In addition to being bitter tonics, these agents act as laxatives or purgatives.

They are employed as mild alterative or resolvent tonics in chronic visceral affections, especially dyspepsia, liver complaints, uterine disorders, &c.

ε. *Amara astringentia.*—Astringent bitters. This group contains those vegetable tonics which possess both bitterness and astringency in an eminent degree. It includes cinchona-bark, elm-bark, and willow-bark. It combines the effects of both bitters and astringents, and is by far the most important group of the class, since it contains cinchona-bark, the most powerful of the vegetable tonics.

3. Tonica Mineralia.—Mineral tonics. This section includes the metallic tonics (see *ante*, pp. 162, 190, and 193), the mineral acids (see *ante*, p. 174), and alum (see *ante*, p. 182).

Sub-order β. Relaxantia deprimentia.—Depressing relaxants. These are agents which depress and lower the tonicity of fibres, and thereby cause relaxation of muscular and other tissues.

To this sub-order belong the *nauseating emetics*, especially emetic tartar (see *emetica*), the *sedatives*, particularly tobacco (see *sedativa*), and the *anæsthetica pneumatica* (see *ante*, p. 209).

These agents are employed to lower the powers of the muscular and vascular systems. Thus they are administered to cause relaxation of the muscles, and thereby to enable the surgeon to effect the reduction of dislocations of the larger joints, and of strangulated herniæ. When they are employed to reduce the power of the heart and arteries they are denominated sedatives, and as such will be noticed hereafter.

β. *Cinetica affecting the irritability of muscles.*—Irritability is a property peculiar to muscular structures, and, unlike tonicity, is increased by warmth, and decreased by cold.

Most physiologists regard irritability as an inherent property in the muscles themselves; but some[1] consider it to be derived from the spinal cord. However this may be, it is admitted by all that the irritability of muscles is greatly under the influence of the nervous system.

The contraction of muscular fibres may be induced by the nervous stimulus (*vis nervosa*), and by stimuli acting directly on the muscular fibre.

The antispasmodic and paralysing effect of opium, and the spasmodic or tetanic condition induced by nux vomica, are referable, at least chiefly, to changes effected in the nervous stimulus, and not to alterations of the contractility of the muscular fibre. For Matteucci[2] found that, in frogs poisoned by opium or nux vomica, when the excitability of the nerves was destroyed, and when the electric current which was applied to them no longer occasioned muscular contractions, the muscles themselves, when submitted directly to the action of the current, underwent contraction.

The cinetica which act on the irritability of muscles are of two kinds,—those which augment, and those which lessen this property. The former produce spasm or convulsions, and may be termed *spastica*; the latter produce a paralysed state, and may be called *paralytica*.

Sub-order γ. Spastica (σπαστικά, from σπάσις, *a convulsion or spasm*); *convulsiva*; *tetanica*. Agents which augment the irritability of muscles and excite spasm or convulsion.—This sub-order includes *strychnia* and *brucia*, and all the vegetable substances containing these alkaloids, as the seed and bark of the stem of *strychnos nux vomica*, the seed of *strychnos ignatia*, snake wood (*lignum columbrinum*), the *upas tieuté*, and perhaps the seed of *cerbera tanghin*. These agents, as I have before stated (see p. 208), excite common sensibility, and act as *hyperæsthetica*. As therapeutical agents they are used, in torpid or paralytic conditions of the muscular system, under regulations which will be pointed out hereafter.

---

[1] Dr. M. Hall, *Medico-Chirurgical Transactions*, vol. xxii.

[2] *Lectures on the Physical Phenomena of Living Beings*, pp. 255–256, Lond. 1847; *Traité des Phénomènes Electro-Physiologiques des Animaux*, pp. 241–242, Paris, 1844.

Cantharides appear to augment the irritability of at least some muscular parts,—the neck of the bladder, for instance, in the treatment of weakness and paralysis of which they are frequently employed with advantage.

CATALEPTICA.—According to Dr. O'Shaughnessy's observations, before referred to (see *ante*, p. 206), *cannabis indica* produces a cataleptic condition. In this state the muscles are moderately contracted, but flexible and pliant, and the limbs retain any position or attitude in which they may be placed. It is, therefore, a modified and moderate degree of tonic spasm; and agents which induce it may be called *cataleptica* (καταληπτικά; from κατάληψις, *catalepsy*). Indian hemp has been used as an antispasmodic, anodyne, and soporific.

SUB-ORDER δ. PARALYTICA (παραλυτικά; from παράλῦσις, *paralysis*).—Agents which diminish the irritability of muscles, and occasion weakness or paralysis.

This sub-order contains *conium maculatum* and its alkaloid *conia*, as well as several of the subdivisions of the order *Phrenica* before noticed; as the *meconica*, *methystica*, *nicotianæ*, and *solanacea mydriatica*.

These agents are important remedies in the treatment of spasmodic affections; and when used in these cases they are termed *antispasmodics* (*antispasmodica*).

Cinetica affecting the movements of the iris.—The movements of the iris are influenced by many medicinal agents.

1. Some cause *mydriasis* or preternatural dilatation of the pupils. These may be called *mydriatica*. Belladonna, stramonium, and hyoscyamus, are the most important agents possessing this property (see *ante*, pp. 203 and 207). They paralyse not only the muscular fibres of the iris, and thereby cause mydriasis, but also the ciliary muscle, and in consequence impair the adjusting faculty of the eye.[1] They are used by oculists for producing dilatation of the pupil.

2. Some agents cause *myosis* or preternatural contraction of the pupil. These may be termed *myositica*. Opium and morphia produce this effect (see *ante*, p. 206).

Indications for the use of the mydriatica or myositica in cerebral diseases have been drawn from the condition of the pupil. Thus Dr. Graves[2] has proposed the employment of belladonna in those cases of fever which are attended with contraction of pupil; and Dr. Holland[3] has suggested that in this condition of pupil opium is contra-indicated.

γ. *Cinetica affecting volition.*—Certain muscles, called voluntary, are under the influence of the *volition* or *will*.

---

[1] See Todd and Bowman's *Physiological Anatomy*, vol. ii. pp. 27, 47, and 48.

[2] *Dubl. Journ. of Medical Science*, July 1, 1838.

[3] *Medical Notes and Reflections*, p. 427, 2d edit. 1840.

1. The influence of the will over these muscles may be increased by stimulating liquors. In the first degree of the effect of the methystica (see *ante*, p. 205) volition may be said to be in excess.

In paralysis, the power of the will over the voluntary muscles is lessened or destroyed. In such cases strychnia and cantharides sometimes augment the influence of volition by heightening the irritability of the muscles.

In some cases, as in chorea and delirium tremens, irregularities occur in the movements of the muscles under the influence of the will. Agents which prevent these, and enable the will to control and regulate the contraction of the muscles in the performance of its acts, may be said to increase and render more perfect the influence of volition over the muscles. Opium and morphia act thus in delirium tremens (see *ante*, p. 206); and arsenic, iron, and zinc, in chorea (see *ante*, pp. 189 and 197).

2. The influence of the will over the muscles is lessened by inebriants and stupefying agents (see *ante*, p. 205). Morphia and opium are the cerebro-spinals usually resorted to in mania to depress excessive voluntary action. They are generally used under the denomination of sedatives.

δ. Cinetica affecting the reflex-spinal functions.[1]—The reflex-spinal acts are independent of the will. They are accomplished by the agency of the *vis nervosa* through the medium of the incident and reflex nerves and their connecting centre.

1. Some medicinal substances excite reflex actions. The sneezing caused by sternutatories, and the vomiting occasioned by emetics, are examples of reflex actions excited by medicines. These reflex acts are accompanied by augmented secretion (see *Class* VIII. *Eccritica*).

2. Some medicinal agents exalt the reflex function. In this exalted state, "stimuli which have no such effect naturally induce morbid and even spasmodic actions" (Hall). Strychnia exalts the reflex function. Under its influence animals are thrown into convulsions by very slight causes, as by the contact of external bodies, and by attempts to walk and to respire. Cantharides exalt the reflex function of the cervix vesicæ, and are useful in enuresis.

3. Some medicinal agents depress the reflex functions. Hydrocyanic acid, conium, belladonna, stramonium, and cannabis indica, may be quoted as examples. Hydrocyanic acid is a valuable remedy for allaying vomiting, hiccup, palpitation, and convulsive cough. Stramonium gives great relief in attacks of spasmodic asthma (see *ante*, p. 200).

In celerity of effect, and rapidity with which they prove fatal, no agents exceed, and few equal, some of those of this group, such as hydrocyanic acid and conia (the active principle of hemlock).

The phenomena (sudden loss of sensation, of volition, and of consciousness, with convulsions) caused by poisonous doses of hydrocyanic acid resemble those of epilepsy. Similar symptoms also sometimes occur from the loss of large quantities of blood. The analogy between these three conditions (*i. e.* hydrocyanic poisoning, epilepsy, and the effect of hemorrhage,) is further shewn by the fact that the symptoms of all are relieved by ammonia.

Alcohol, ether, ammonia, the fetid gum-resins, the empyreumatic oils and resins, and the essential oils, are valuable *antispasmodics* in convulsive and spasmodic diseases occurring in weakly subjects and unattended by inflammation. They "act as stimulants to the heart and vessels, and to the cerebral functions, [and] seem to operate as sedatives to the medullary system."[1] (See *Stimulantia.*)

---

[1] On this subject the reader is referred to Dr. Marshall Hall's valuable works: *Memoirs on the Nervous System*; *Diseases and Derangements of the Nervous System*; and his *New Memoir on the Nervous System*.

Certain metallic substances (arsenic, zinc, iron, silver, and copper) "have some power in reducing the excitability of the spinal excito-motory system," and are useful in relieving chorea, epilepsy, and other convulsive affections (see *ante*, pp. 190 and 196).

ORDER 4. HYPNICA (ὑπνικά, from ὕπνος, *sleep*). Agents affecting sleep.

The hypnica are of two kinds,—those causing sleep, and those which check or prevent it. The former are called ***hypnotica***, the latter may be termed ***agrypnotica***.

SUB-ORDER *α*. HYPNOTICA (ὑπνωτικά; from ὑπνόω, ***I lull to sleep***). ***Hypnopœi; somnifica; somnifera.*** Agents causing sleep.

The most important hypnotics are the agents already referred to under the order ***Phrenica***, especially the ***meconica***, ***methystica***, ***cannabina***, and ***solanacea mydriatica***. To these may be added ***lactuca sativa***, ***l. virosa***, ***lactucarium***, ***myristica officinalis***, and ***humulus lupulus***.

SUB-ORDER *β*. AGRYPNOTICA (ἀγρυπνωτικά; from ἀγρυπνόω, ***I cause to lie awake***). ***Anthypnotica.*** Agents which cause wakefulness.

One of the most powerful preventers of sleep, especially in the constitutions called nervous, is *tea* (particularly strong green tea). *Coffee* also appears to have an analogous effect. *Digitalis*, which agrees with tea in some of its effects, checks sleep when taken in full doses. *Vinegar* is considered by Orfila to counteract the narcotic effects of opium after the poison has been evacuated from the stomach.

LOCALITY AND QUALITY OF THE ACTION OF THE CEREBRO-SPINALIA.—Most of the differences observed in the operation of the cerebro-spinalia arise from different parts of the nervous centres being affected, or from the same parts being unequally acted on.

The attempts hitherto made to localize the action of the cerebro-spinalia have not been attended with success. Flourens[2] thinks that opium acts specifically on the cerebral lobes; that belladonna, in a limited dose, affects the tubercula quadrigemina, and, in a larger dose, the cerebral lobes also; that alcohol, in a limited dose, acts exclusively on the cerebellum, but, in a larger quantity, affects also neighbouring parts; and, lastly, that nux vomica more particularly influences the medulla oblongata.

One source of difficulty which attends all attempts made to ascertain the nature of the changes which the cerebro-spinalia induce in the nervous centres is the fact that similar symptoms attend dissimilar affections.

Thus *coma* may be induced by compression of the cerebrum or by loss of blood. *Delirium* may arise from irritation of the cerebrum or from loss of blood. *Convulsions* may be produced by irritation, or lesion of the medulla oblongata and spinalis, or by loss of blood. *Paralysis* may arise from lesion of the encephalon, destructive injury of the medulla oblongata or spiualis, and loss of blood.

Alterations in the quantity or quality of the blood supplied to the different parts of the cerebral and spinal systems, are the primary causes of the changes which the cerebro-spinalia produce in the condition of the functions of these systems.

---

[1] *Principles of Medicine*, by Dr. C. J. B. Williams, p. 72.

[2] *Recherches expérimentales sur les Propriétés et les Fonctions du Système Nerveux dans les Animaux vertébrés*, pp. 254, 258, 261, and 262, Paris, 1824.

Augmented arterial action, or venous congestion, sometimes attends the operation of the cerebro-spinalia. Flourens declares that opium, belladonna, alcohol, and nux vomica, give rise to phenomena resembling those which attend mechanical lesions of the parts on which he asserts these agents operate (see above); and furthermore he states, that in birds it is possible to observe, through the cranium, changes of colour [some alterations in the vascular conditions of the parts] which these agents effect in the brain: but, in repeating his experiments, I failed in observing the changes referred to.

I have already noticed the attempts made to explain the action of alcohol on the nervous centres on physical and chemical principles (see *ante*, pp. 91, 92, 98, and 113).

Alterations effected in the qualities of the blood by abnormal changes going on within the system, may, in some cases, be the cause of insanity.[1]

MODE OF DEATH.—As the sub-class cerebro-spinalia includes the most energetic and swiftly acting poisons, the mode in which these agents produce death becomes a most interesting topic of inquiry: the more especially so, as the consideration of the subject leads to some practical conclusions as to the most appropriate methods of treating cases of poisoning by these substances.

Usually, if not invariably, the deadly effect begins in the cerebro-spinal system, and is produced by the action of the poison contained in the blood on the nervous tissue. In some cases, perhaps, the primary effect may be on the blood, the vitality of which becomes destroyed.

When the deadly effect begins in the cerebro-spinal system, death is occasioned by apnœa or by syncope, or by both.

1. *Death by apnœa.*—In death by apnœa, or breathlessness, the respiration ceases before the stoppage of the heart's action.

Apnœa may be induced by paralysis of the muscles of respiration, or by spasm of these parts.

Paralytic apnœa is produced by conium, opium, hydrocyanic acid, belladonna, stramonium, and various other agents. It depends on defect of the reflex or excito-motory action.

These are the cases in which it has been proposed to prolong life by artificial respiration until the effect of the poison has passed off. The proposition is not supported merely by its ingeniousness and plausibility, but by experience. The following is a case in point, related by Mr. Whateley, and quoted by Dr. Christison:[2]—A middle-aged man swallowed half an ounce of crude opium, and soon became lethargic. He was roused from this state by appropriate remedies, and his surgeon left him; but, the poison not having been sufficiently discharged, he fell again into a state of stupor; and when the surgeon returned he found the face pale, cold, and deadly, the lips black, the eyelids motionless, so as to remain in any position in which they were placed, the pulse very small and irregular, and the respiration quite extinct. The chest was immediately inflated by artificial means; and, when this had been persevered in for seven minutes, expiration became accompanied with a croak, which was gradually increased in strength till natural breathing was established; emetics were then given, and the patient eventually recovered.—A most interesting case of recovery from poisoning by opium, by artificial respiration, has been detailed by Mr. Howship.[1]—Another case I have already (see *ante*, p. 201) briefly noticed.

---

[1] On this subject, see *Observations on the Proximate Cause of Insanity*, by James Sheppard, M.R.C.S., *being an Attempt to prove that Insanity is dependent on a Morbid Condition of the Blood*, Lond. 1844. Also, *Du Hachish et de l'Aliénation Mentale, Etudes Psychologiques*, par J. Moreau, Paris, 1846 (Forbes's *Brit. and Foreign Med. Rev.*, vol. xxiii.)

[2] *Treatise on Poisons*, p. 680, 3d edit.

I have several times restored animals, apparently dead from the use of hydrocyanic acid, merely by keeping up artificial respiration; and Sir Benjamin Brodie has done the same with animals apparently killed by the oil of bitter almonds.

In a case of complete insensibility from intoxication, related by Mr. Sampson,[2] the comatose state was thought to arise, not from apoplexy, "but from torpor of the brain, in consequence of that organ being imperfectly supplied with blood not duly oxygenated, for the shrill tone and extreme difficulty of respiration showed the existence of collapse of the glottis, and imperfect transmission of air into the lungs, which might be accounted for by a paralysed state of the eighth pair of nerves and recurrent branches." Tracheotomy was performed, and with complete success: in about half an hour the respiration was regular and easy through the wound.[3]

Spasmodic apnœa is of two kinds, laryngeal and thoracic. In *laryngeal* spasmodic apnœa the larynx is spasmodically closed. This condition occurs when an attempt is made to inspire carbonic acid and some other gases (see *ante*, p. 117). In *thoracic* spasmodic apnœa the muscles of respiration are thrown into a spasmodic state, whereby respiration is stopped. In this case reflex action is augmented. Strychnia, brucia, and the substances containing these alkaloids, act in this way.

2. *Death by syncope.*—In death by syncope the heart ceases to beat before respiration stops.

Syncope may be induced by paralysis of the heart, or by spasm of this organ.

Paralytic syncope is produced by tobacco, foxglove, aconite, the upas antiar, and probably by several other poisons.

In poisoning by agents which paralyse the heart it has been proposed to stimulate this organ by slight galvanic shocks, in order to avert the fatal termination. Even acupuncture has been advised, if the patient appear in *articulo mortis*. Bretonneau[4] has repeatedly punctured the brain, heart, lungs, and stomachs of young dogs without the least inconvenience; and Carraro[5] has successfully tried this practice on animals in a state of asphyxia.

Spasmodic syncope is sometimes the cause of death. "In sudden death from drinking a quantity of raw spirits, or of very cold water when the body is heated, the heart has been found contracted."[6]

Sub-class 2. *Ganglionica.* Ganglionics.

These are medicinal agents which affect the sensibility or muscular motion of parts supplied by the ganglionic or sympathetic system of nerves.

The sympathetic nerve exercises a threefold function: it acts as a sensitive nerve to the parts to which it is distributed; it is a motor nerve for certain muscular parts; and it exercises an influence on the contractility of the bloodvessels and on the functions of nutrition and secretion. But inasmuch as the influence of medicines on the organic functions of this nerve is very obscure, and as I have devoted a special class (*Eccritica*) to medicines acting on the secernent system, I have thought it advisable to include under the denomination of ganglionica those agents only which affect the sensation or the motion of parts to which this nerve is distributed.

---

[1] *Medico-Chirurgical Transactions*, vol. xx. p. 86.

[2] *Ibid.* vol. xx. p. 46.

[3] Dr. Marshall Hall (*On the Diseases and Derangements of the Nervous System*, p. 280,) considers the case to have been one of "paralysis of the pneumo-gastric nerve and of the dilator muscles of the larynx;" and that the same condition occurs, not only in intoxication, but probably in other cases of coma, as in that of apoplexy, of epilepsy, from opium, &c.

[4] Bayle, *Travaux Thérapeutiques*, t. i. p. 432.

[5] *Expériences sur des animaux asphyxiés et ramenés à la vie par l'acupuncture du cœur*, in Bayle, *op. cit.* t. i. p. 495.

[6] *Principles of Medicine*, by C. J. B. Williams, M.D. p. 375, Lond. 1843.

1. *Affecting the heart and arteries.*—Sometimes we are called on to augment the frequency and force of the heart's action. We endeavour to do this by the agents called *stimulants*. Sometimes our object is to reduce the force and frequency of the action of the heart by the agents termed *sedatives*. At other times we are required to control irregularities of the heart's action, or to appease acute pain referred to the heart.

For irregularities (such as palpitation, &c.) of the heart's action we have no particular class of remedies. Our treatment must vary with the causes producing them. For painful affections referred to the heart (such as the pain of angina) our most powerful remedies are the anæsthetics before mentioned (see p. 208), especially opium and ether. On the present occasion we have to notice only two classes of agents, viz. stimulants and sedatives.

ORDER 1. STIMULANTIA (from *stimulus*, a goad or spur); *excitantia; incitantia; calefacientia; sthenica; hypersthenica; diffusible stimuli.*[1] "A stimulant is that which, through the medium of the nervous system, increases the action of the heart and other organs, by calling forth the nervous influence, or by facilitating the extrication of it in them" (Billing[2]).

Great confusion of ideas and of language has existed with respect to the distinction between *stimulants, sedatives, narcotics,* and *tonics*. The real difference between them has been ably and clearly pointed out by my friend Dr. Billing. "Stimulants," he observes, "promote the extrication of nervous influence, as evinced by increased action; sedatives the reverse. Narcotics do not appear to alter the quantity of nervous influence, but merely to impede its communication." Tonics, on the other hand, "neither immediately nor sensibly call forth actions like stimulants, nor depress them like sedatives, but give power to the nervous system to generate or secrete the nervous influence by which the whole frame is strengthened."

The agents used as stimulants frequently contain, besides their stimulating principle, another agent endowed with different properties. Thus cinnamon contains, besides its stimulating principle (*volatile oil*), an astringent substance (*tannic acid*); cascarilla and chamomiles contain both a stimulating (*volatile oil*) and a tonic principle (*bitter extractive*). Such agents, therefore, possess a two-fold power.

Sometimes the same principle produces, under different circumstances, apparently different effects. Thus brandy in moderate quantities acts as a stimulant; but taken in excess it overpowers the brain, exhausts the nervous power, and impedes its generation, disengagement, and communication; thus acting both as a sedative and narcotic.

---

[1] In the language of Brown, *diffusible stimuli* are stimuli which possess an operation as much quicker and more powerful than that of the articles of diet, as their operation is of shorter duration. (*The Works of Dr. John Brown*, vol. ii. p. 230, Lond. 1804.) "The most weak degree of the diffusible stimuli are the white wines, except madeira, canary, good sherry; and the red wines, except port, and spirits produced by distillation, so diluted as to equal the strength of the wines, or exceed it a little. Still higher than these are the latter taken pure; and higher still those which have undergone many rectifications; the strength of which is in proportion to the quantity of water expelled, and of the alcohol retained. A higher place in the scale is claimed by musk, volatile alkali, camphor,—our trials of which are not yet so complete as to ascertain its force exactly; next comes ether, and, last of all, opium."

[2] *First Principles of Medicine*, by A. Billing, M.D., A.M., 4th edit. p. 77, 1841.

The topical action of stimulants is not necessarily accompanied with any obvious changes, either chemical or anatomical. Some stimulants act chemically on the parts with which they are placed in contact; *e. g.* alcohol and ammonia (see *ante*, p. 98): and many of them operate as acrids (see p. 169), and produce hyperæmia of the parts to which they are applied. But these effects are not produced by all agents when acting as stimulants, and therefore cannot be considered as essential to their action. All affect the gustatory organ; their taste being warm, pungent, and acrid. Most of them produce a sensation of heat and pain when applied to delicate parts of the skin or to the mucous surfaces. Swallowed in moderate quantities, they give rise to a sensation of warmth in the stomach, promote the contraction of the muscular coat of the stomach and intestines, and thereby expel gaseous matters, and assist digestion. In general they produce hyperæmia and increased secretion of the mucous follicles of the gastro-intestinal surface. In larger quantities they excite thirst, and often give rise to nausea or vomiting.

The active principle of most, if not all of them, becomes absorbed, in some cases, perhaps, after having undergone a greater or less chemical change. Ether, alcohol, and the volatile oils are rapidly absorbed; the resinous substances more slowly. Those which are very slowly absorbed are frequently in part evacuated with the excrements before sufficient time has elapsed for their total absorption. Many of them have been recognized in the blood by their odour (*e. g.* turpentine, alcohol, camphor, the odorous principle of musk and assafœtida, and Dippel's oil, see *ante*, p. 104). These, therefore, have been absorbed unaltered. A very large number of them have been recognized in the secretions by their unaltered odour (see *ante*, pp. 105 and 106). In the urine and breath they have been especially recognized. In some cases, however, the odour has undergone a change; as in the case of the oil of turpentine, which communicates a violet odour to the urine.

While in the blood they act as stimulants to the heart and blood-vessels, and increase the frequency and fulness of the pulse. They do this probably by coming in contact with the surfaces of these parts, the organic nerves of which are susceptible of the impression of the stimulating particles.

In their passage out of the system through the secretory organs, stimulants act as topical agents, and augment secretion (see *ante*, p. 114). Hence we find among them some of our most powerful and effective expectorants, sudorifics, and diuretics. Exanthematous eruptions are produced by some of them (*e. g.* copaiba, cubebs, &c.)

The augmented action of the heart and arteries is attended with quickened respiration, and an increase of the temperature of the superficial and remote parts of the body; whence the stimulants are frequently termed *calefacients*.

The brain and spinal cord are stimulated to a more active performance of their functions by the more copious supply of blood which they receive. In some cases functional disorder of these parts is produced.

In this way, the stimulants, by causing an increased supply of blood to the various parts of the body, act physiologically as functional exalters, or pathologically as exciters of a febrile state.

Stimulants are used for various purposes, of which the following are the most important:—

1. As topical stimulants, or *acrids*. The uses of these have been already briefly noticed (see pp. 169).

2. As stimulants to the gastro-intestinal canal they are frequently employed. When administered in dyspeptic cases to promote digestion they are called *stomachics* (*stomachia*, στομᾱχῐκά); and when given to dispel flatulence and relieve colicky pain they are termed *carminatives* (*carminativa; from carmen*, a charm), or *physagogues* (*physagoga;* φυσαγωγά, from φῦσα, *flatus*, and ἀγωγός, *carrying off*).

3. As stimulants to the heart and vascular system they are employed under the name of *cordials* (*cardiaca*; καρδιακά, from καρδία, *the heart*, also *the upper orifice of the stomach*), or *restoratives* (*analeptica*; αναληπτικά, from ἀνάληψις, *recovery* or *restoration*).

4. As stimulants to the brain they are used under the denomination of *nervines* (*nervina*), to arouse the energies and correct certain disorders of the nervous system. When these disorders are of a spasmodic nature the remedies often bear the name of *antispasmodics* (*antispasmodica*); and when the malady is an hysterical one, they are termed *antihysterics* (*antihysterica*).

5. As stimulants to the secreting organs they are frequently used to increase, to alter, and in some cases to check, secretion.

When used to increase secretion they are called *evacuants* (*evacuantia*); and, according as they act on the bronchial membrane, the skin, the kidneys, the uterus, &c., they bear the name of *expectorants* (*expectorantia*.) *sudorifics* (*sudorifica*), *diuretics* (*diuretica*), *emmenagogues* (*emmenagoga*), *diuretics* (*diuretica*), &c. (See Class VIII. *Eccritica*.)

In asthenic fluxes from the mucous surfaces, stimulants are frequently used to modify and check secretion. In such cases they appear to act as astringents. The efficacy of brandy and spices in diarrhœa,—of cubebs, copaiba, and cantharides in leucorrhœa and gonorrhœa,—and of the fetid gums and balsams in bronchorrhœa,—must be familiar to every one. These different agents probably act topically, through the circulation, on the secreting organs; but how, is uncertain. In a general way they may be said to operate on the principle of counter-irritation (see *ante*, pp. 127-129).

Stimulants are the remedies for asthenic disorders. The general indication for their employment is exhaustion. They are well adapted for certain nervous and spasmodic diseases, as hysteria; in which there is great nervous excitement, a feeble circulation, and debility.

They are contra-indicated in maladies of a sthenic character; in acute inflammation, ardent fever, hyperæmia, and plethora.

The active principles of the stimulants are *volatile oil*, *resin*, *benzoic* and *cinnamic acids*, *ammonia*, *phosphorus*, and the *methystica*.

The stimulants may be arranged, according to the nature of their active principles, in six sub-orders, as follows:—the *æthereo-oleosa*, the *resinosa*, the *ammoniacalia et empyreumatica*, the *excreta animalia*, *phosphorus*, and the *spirituosa et ætherea*.

SUB-ORDER *α*. ÆTHEREO-OLEOSA VEGETABILIA.—These are vegetable stimulants which owe their medicinal powers to volatile oil wholly or chiefly.

Magnoliaceæ.
Drimys Winteri—*Cortex.*
Cruciferæ.
Cardamine pratensis—*Herba.*
Cochlearia Armoracia—*Radix.*
" officinalis—*Herba.*
Sinapis alba—*Semina.*
" nigra—*Semina.*
Polygaleæ.
Polygala Senega—*Radix.*
Aurantiaceæ.
Citrus Aurantium — *Cortex fructûs, Flores, Oleum è floribus destillatum.*
" Limonum — *Cortex fructûs, Oleum è fructû expressum.*
" Bergamia—*Oleum è fructû destillatum.*
" vulgaris—*Cortex fructûs, Oleum è floribus destillatum.*
Guttiferæ.
Canella alba—*Cortex.*
Rutaceæ.
Ruta graveolens—*Herba, Oleum.*
Barosma crenata—*Folia.*
Rosaceæ.
Rosa centifolia—*Oleum è floribus destillatum.*
Myrtaceæ.
Melaleuca minor—*Oleum Cajuputi.*
Caryophyllus aromaticus—*Flores nondum explicati, Oleum.*
Eugenia Pimenta—*Fructus, Oleum.*
Umbelliferæ.
Fœniculum dulce—*Fructus, Oleum.*
Anethum graveolens—*Fructus, Oleum.*
Archangelica officinalis—*Radix.*
Carum Carui—*Fructus, Oleum.*
Coriandrum sativum—*Fructus.*
Cuminum Cyminum—*Fructus.*
Daucus Carota—*Radix, Fructus.*
Pimpinella Anisum—*Fructus, Oleum.*
Caprifoliaceæ.
Sambucus nigra—*Flores.*
Valerianaceæ.
Valeriana sylvestris—*Radix.*
Compositæ.
Inula Helenium—*Radix.*
Anthemis nobilis—*Flores, Oleum.*
Anacyclus Pyrethrum—*Radix.*
Artemisia Absinthium—*Herba.*
Tanacetum vulgare—*Herba.*
Arnica montana—*Flores.*

Labiatæ.
Hyssopus officinalis—*Herba.*
Lavandula vera—*Flores, Oleum.*
Melissa officinalis—*Herba.*
Mentha piperita—*Herba, Oleum.*
" Pulegium—*Herba, Oleum.*
" viridis—*Herba, Oleum.*
Majorana hortensis—*Herba.*
Origanum vulgare—*Oleum ex herbâ.*
Rosmarinus officinalis—*Herba, Oleum.*
Salvia officinalis—*Herba.*
Myristaceæ.
Myristica officinalis—*Nux, Macis, Olea.*
Lauraceæ.
Cinnamomum Cassia—*Cortex, Oleum.*
" Zeylonicum—*Cortex, Oleum.*
Camphora officinarum—*Camphora.*
Laurus nobilis—*Baccæ.*
Sassafras officinale—*Lignum, Oleum.*
Aristolochiaceæ.
Aristolochia Serpentaria—*Radix.*
Asarum Europæum—*Folia.*
Euphorbiaceæ.
Croton Eleuteria—*Cortex.*
Piperaceæ.
Piper nigrum—*Fructus.*
" longum—*Fructus.*
" Cubeba—*Fructus, Oleum.*
Urticaceæ.
Humulus Lupulus—*Strobili, Oleum.*
Dorstenia Contrayerva—*Radix.*
Coniferæ.
Juniperus Sabina—*Cacumina.*
" communis—*Fructus, Oleum.*
Pinus; plurimæ species—*Oleum.*
Orchidaceæ.
Vanilla aromatica—*Fructus.*
Zingiberaceæ.
Zingiber officinale—*Rhizoma.*
Elettaria Cardamomum—*Semina.*
Curcuma longa—*Rhizoma.*
" Zedoaria—*Rhizoma.*
Iridaceæ.
Crocus sativus—*Stigmata.*
Liliaceæ.
Allium sativum—*Bulbus.*
" Cepa—*Bulbus.*
Acoraceæ.
Acorus Calamus—*Rhizoma, Oleum.*

Considered with reference to their chemical composition the volatile oils are of two kinds,—the sulphurated and the non-sulphurated.

a. Sulphurated volatile oils.—Of these the most important and best known are the oils obtained from alliaceous and cruciferous plants, and whose hypothetical radical is *allyle* ($All = C^6H^5$).

These oils may be termed the *allyle oils,* to distinguish them from other sulphurated oils. They are obtained by distillation with water from the respective plants: they are heavier than water, have a very pungent fetid smell, and an acrid burning taste, and, when applied to the skin, cause redness and vesication. Their vapours cause a copious flow of tears.

The allyle oils are of two kinds: some consist of sulphuret of allyle[1] (AllS), others of sulphocyanide of allyle (AllCyS). The former are obtained from Liliaceæ, the latter from Cruciferæ.

OFFICINAL ALLYLE OILS.

From Liliaceæ. (AllS.)	*From Cruciferæ.*[2] (AllCyS.)
Oil of Allium sativum.	Oil of Sinipis nigra.[3]
" Cepa.	" Cochlearia Armoracia.
" Porrum.	" " officinalis.

The oils (AllCyS) obtained from Cruciferæ by distillation with water do not exist ready formed in the vegetables from which they are procured, but are produced by the mutual action of substances existing in the plants, aided by water.

The oil of hops (*Humulus Lupulus*) contains sulphur; but it probably does not belong to the allyle series.

β. *Non-sulphurated volatile oils.*—These are of two kinds,—oxygenated and non-oxygenated.

Non-oxygenated oils are compounds of carbon and hydrogen, and their empirical formula is $C^{10}H^{8}$. The following oils belong to this section:—

Volatile oils of Coniferæ.	*Volatile oils of Aurantiaceæ.*	*Volatile oils of Piperaceæ.*
Oil of turpentine.	Oil of lemons.	Oil of pepper.
Oil of juniper.	Oil of citron, or	Oil of cubebs.
Oil of savine.	Oil of cedrate.	
	Oil of neroli (orange flower).	*Volatile oils of Myrtaceæ.*
Volatile oil of Zingiberaceæ.	Oil of oranges (both bitter and sweet).	Light oil of cloves.
Oil of cardamoms.		Light oil of allspice (?).

If they "be distilled with quicklime in vacuo, or in an atmosphere of carbonic acid, the product is absolutely inodorous: and it is impossible in this state to discriminate oil of lemons from oil of turpentine or of juniper; but, when exposed to the air, they quickly become odorous, while they absorb oxygen, becoming viscid and resinous. It would appear, therefore, as if the odour accompanied the act of oxidation, as is the case with metallic arsenic."[4]

The *oxygenated essential oils* are usually mixtures of several oils differing in volatility. To this series belong the volatile oils of the officinal Iridaceæ, Euphorbiaceæ, Lauraceæ, Myristicaceæ, Labiatæ, Compositæ, Valerianaceæ, Umbelliferæ, Myrtaceæ (the oils heavier than water), and Rosaceæ.

The non-sulphurated oils of this sub-order are frequently associated with resin: in some cases this appears to be formed by the oxidation of the volatile oil.

---

[1] Assafœtida contains two volatile oils, one of which appears to be sulphuret of allyle.

[2] The volatile oils of a considerable number of cruciferous plants, besides those mentioned in the text, are sulphocyanides of allyle (see Wertheim, *Chemical Gazette*, vol. iii. pp. 177, 186, and 495; Will, *Ch. Gaz.* vol. iii. 253 and 277; Pless, *Ch. Gaz.* vol. iv. p. 252).—*Cardamine pratensis* probably contains sulphocyanide of allyle.

[3] White mustard, *sinapis alba*, does not yield the same oil as black mustard.

[4] Turner's *Elements of Chemistry*, edited by Baron Liebig and Dr. Gregory, 8th edit. part ii. p. 1130.

Some of the æthereo-oleosa, whose non-sulphurated oils have a very agreeable and fragrant odour, are employed as *perfumes*; and some of them are used in medicine for the purpose of scenting lotions, ointments, &c. (see *ante*, pp. 2, 3, and 167.)

Others are used as *condiments* or *seasoners*. At the head of these stand the *spices* (*aromata*), products of warm climates, distinguished by their agreeable, warm flavour, and, in some cases, by considerable pungency or acridity. The most important of them are cinnamon, cassia, ginger, turmeric, zedoary, nutmegs, mace, pimento, cloves, the peppers, cardamoms, saffron, and vanilla. Next to these, but inferior to them in strength and fineness of aroma, come the *sweet* and *savoury herbs*, obtained chiefly from Labiatæ and Umbelliferæ. They are cultivated in this country, and are used by the cook for soups, stews, savoury dishes, stuffing, &c. The fruits of some of the Umbelliferæ are used under the name of *seeds* by confectioners for flavouring cakes, &c. Several of the spices, and some of the herbs and umbelliferous fruits, are used by the distiller for flavouring liqueurs.

The alliaceous and cruciferous plants from which the allyle oils are obtained are used dietetically as *salads* (*acetaria*), *pot-herbs* (*olera*), and *condiments*. They constitute the *officinal volatile pungent stimuli* of Dr. Duncan. They are esteemed antiscorbutic.

Considered therapeutically, the æthereo-oleosa are used for several purposes, of which the most important are the following:—

1. To communicate an agreeable flavour or smell to medicinal compounds (see *ante*, pp. 2 and 3), and for the purpose of fumigation (see *ante*, p. 167).

2. As topical stimulants or acrids (see *ante*, p. 169, *et seq.*)

3. As gastro-intestinal stimulants they are employed under the denomination of stomachics, carminatives, antispasmodics, and cordials. The spices and the æthereo-oleosa obtained from Labiatæ, Umbelliferæ, and Compositæ, are frequently used for these purposes. In enfeebled or relaxed habits they are employed to assist digestion. In flatulency and spasm of the alimentary canal, especially the flatulent colic of children, they are administered as carminatives and antispasmodics. They are also used to allay colicky pains, to correct the griping qualities of some cathartics, and to check purging in mild forms of diarrhœa. For the latter purpose nutmegs are especially serviceable, on account of their narcotic properties.

On account of their acrid and heating properties, spices are objectionable in inflammatory conditions of the alimentary canal, and in febrile states of system.

4. As stimulants to the cerebro-spinal system, camphor, valerian, rue, arnica, serpentary, &c., are frequently used; sometimes, under the denomination of nervines and antispasmodics, in nervous, hypochondriacal, and hysterical complaints, and in some of the spasmodic and convulsive affections of weakly subjects; sometimes to relieve nervous exhaustion in the latter stages of continued fever.

5. As stimulants to the urino-genital apparatus the coniferous æthereo-oleosa, as well as rue, buchu, &c., are used as diuretics and emmenagogues, and to modify the condition of the mucous membrane of the bladder (see *Class* VIII. *Eccritica*).

6. As sudorifics (see *Class* VIII. *Eccritica*).

SUB-ORDER β. RESINOSA. *Resinous Stimulants*. These are vegetable stimulants which owe the whole or part of their activity to resin. The following are the most important of them :—

Zygophyllaceæ.
Guaiacum officinale—*Lignum*, *Cortex*, *Resina*.
Terebinthaceæ.
Pistacia Lentiscus—*Resina*.
" Terebinthus—*Terebinthina chia*.
Boswellia thurifera—*Gummi-resina*.
Balsamodendron Myrrha—*Gummi-resina*.
Icica Icicariba—*Resina Elemi*.
Canarium commune—*Resina Elemi* (?).
Leguminosæ.
Copaifera : plurimæ species—*Resina liquida*.
Myrospermum peruiferum—*Balsamum*.
" toluiferum—*Balsamum*.
Umbelliferæ.
Narthex Assafœtida—*Gummi-resina*.
Ferula (?) " *Gummi-resina* (*sagapenum*).
Dorema Ammoniacum—*Gummi-resina*.
Opoponax chironium—*Gummi-resina*.
Galbanum officinale—*Gummi-resina*.
Compositæ.
Anacyclus Pyrethrum—*Radix*.
Styraceæ.
Styrax Benzoin—*Balsamum*.
" officinale (?)—*Balsamum*.
Solanaceæ.
Capsicum annuum—*Fructus*.
Thymelaceæ.
Daphne Mezereum—*Radicis cortex*.
Coniferæ.
Pinus palustris
" tæda
" Pinaster
" sylvestris
—*Terebinthina vulgaris*, *Resina vulgaris*.
Abies excelsa—*Abietis resina*, *Pix Abietina*.
" balsamea—*Balsamum Canadense*.
" piccea—*Terebinthina Argentoratensis*.
Larix europæa—*Terebinthina Veneta*.
Liliaceæ.
Xanthorrœa hastile—*Resina*.

Considered with respect to their chemical nature, the resinosa may be arranged in four groups, as follows :—

1. *Resinæ*, or Resins properly so called. These consist essentially of resin only. Such are guaiacum, mastic, elemi, and common resin, usually denominated rosin. To this group, also, belong the active principles of mezereon and capsicum.

2. *Oleo-resinæ*, or Oleo-resins.—These are semi-liquid or glutinous juices composed of volatile oil and resin. They are sometimes called *balsams*. Such are the various kinds of turpentines (including Canada balsam) and copaiba.

3. *Resinæ benzoicæ* vel *cinnamicæ*.—Resins which contain or yield benzoic or cinnamic acid. To these the term *balsam* has, by some, been exclusively applied. To this group belong the balsams of peru and tolu, benzoin, storax, and the resin of Xanthorrœa hastile.

4. *Gummi-resinæ*.—Gum-resins. These consist of gum and resin, usually with traces of volatile oil. The gum-resins obtained from the family Umbelliferæ,—viz. assafœtida, galbanum, sagapenum, ammoniacum, and opoponax,—contain a sulphurated volatile oil (sulphuret of allyle?), and are commonly distinguished as the *fetid gum-resins* (*gummi-resinæ fœtidæ*; *gummi-ferulaceæ*). The other gum-resins, which may be distinguished as *simple gum-resins*, are myrrh and olibanum.

The resinosa are all local irritants; the oleo-resinæ being the most powerful. When applied to the skin they occasion redness, and, in some cases, inflammation. When swallowed, they occasion more or less irritation of the alimentary canal, according to the nature of the agent, and the dose in which it is taken; the symptoms being epigastric heat, loss of appetite, nausea, and even vomiting, and sometimes, when the quantity swallowed is large, griping or purging.

They become absorbed, at least partially, if not wholly. Several of them, have been detected in the blood by their odour. In various secretions, also, they have been recognised (see *ante*, pp. 105, 106, 114).

After their absorption they operate as stimulants on the general system; quickening the pulse, increasing the heat of the skin, and producing a kind of febrile condition. They exercise a stimulant influence over the secreting organs, especially the kidneys, the mucous surfaces, and the skin. The effect of the oleo-resins on the urinary organs is manifested by uneasiness in the region of the kidneys, increased desire of passing the urine, heat in the urethra, and sometimes strangury and bloody urine. Under the influence even of small doses the urine acquires a remarkable odour; which, when any of the turpentines have been taken, is that of violets. The mucous membranes generally are stimulated, and, in fluxes, the secretions are frequently diminished. By repeated use they sometimes cause a cutaneous eruption.

The central organs of the nervous system are affected by several of them. Thus oil of turpentine in large doses disorders the cerebral functions. The fetid gums affect the reflex-spinal functions and act as antispasmodics (see *ante*, pp. 211 and 212).

The following are some of the more important uses of the resinous stimulants:—

1. Some are employed as local irritants or acrids (see pp. 168-170).

2. The oleo-resins and olibanum are principally employed in medicine to relieve fluxes, especially of the urino-genital mucous membrane. Thus they are employed, and with great benefit, in gonorrhœa, leucorrhœa, gleet, and chronic catarrh of the bladder. In chronic pulmonary catarrhs they are sometimes advantageously employed; but not unfrequently prove injurious, as Dr. Fothergill[1] has shown.

The balsams (benzoic and cinnamic resins) are also used as stimulants to the mucous membrane lining the air-passages. MM. Trousseau and Pidoux[2] assert, from their own experience, that "there are few substances in the materia medica so powerful in combating chronic pulmonary catarrhs and old laryngeal inflammations as the balsams." In chronic inflammation of the larynx, whether accompanied or not by ulceration, balsamic fumigations are more serviceable than the internal exhibition of the balsams. The air of the patient's chamber may be impregnated with balsamic vapours by placing a little benzoin or tolu on some live coals, and allowing the vapour to escape into the room; or the patient may inhale the vapour of boiling water to which a drachm or two of the balsams have been added.

3. The fetid gum-resins have been principally, and most successfully, employed in hysteria, flatulent colic, and spasmodic asthma. Their antispasmodic influence has been before alluded to (see *ante*, pp. 211-212).

Myrrh does not possess the antispasmodic power of the fetid gums, but approaches nearer to the tonics.

4. Several of the resinosa are used as emmenagogues, diuretics, and sudorifics (see *Class* VIII. *Eccritica*).

5. Oil of turpentine has been used in neuralgia, against tape-worm, in puerperal peritonitis, and in other cases to be mentioned hereafter.

6. The liquid balsams (of styrax and peru) are sometimes applied to chronic indolent ulcers to allay pain, to improve the quality of the secreted matter (*detergents*), and to promote cicatrization (*epulotics* or *cicatrisantia*).

---

[1] *Medical Observations and Inquiries*, vol. iv. p. 231.

[2] *Traité de Thérapeutique*, t. i. p. 467.

SUB-ORDER γ. AMMONIACALIA ET EMPYREUMATICA.—This sub-order contains ammoniacal stimulants (ammonia and its carbonates) and the empyreumatic oils and resins.

The following are the more important substances of this sub-order :—

AMMONIACALIA.

Ammonia.
Liquor ammoniæ.
Ammoniæ carbonas.
Ammoniæ sesquicarbonas.
Ammoniæ bicarbonas.

EMPYREUMATICA.

α. *Olea ætherea.*
  Oleum animale æthereum seu Dippelii.
  Oleum cornu cervi rectificatum.
  Oleum succini rectificatum.
  Creasoton.
  Oleum petræ (petroleum rectificatum).
β. *Oleo-resinæ.*
  Pix liquida—*Aqua Picis.*
γ. *Resinæ.*
  Pix nigra.

AMMONIACALIA ET EMPYREUMATICA.

Liquor ammoniæ carbonatis empyreumaticus (v. *spiritus cornu cervi*).

Both ammoniacalia and empyreumatica are obtained by the dry distillation of substances of an organic origin. In some cases (as in the distillation of bones, hartshorn, and coal) both classes of compounds are simultaneoualy developed. For this reason, as well as that the two classes agree in some respects in their medicinal properties, and are often associated for medicinal use (ex. *spiritus cornu cervi,* and *tinctura ammoniæ composita,* Ph. Lond.), I have thought it expedient to group them together.

The general chemical nature of the substances of this sub-order is shewn in the table. The chemical properties of the individual agents will be noticed hereafter.

The ammoniacalia and empyreumatica are powerful local irritants, several of them (*e. g.* ammonia and creosote) acting chemically (see *ante,* pp. 98, 180, and 181).

When swallowed, some of them undergo chemical change before their absorption; as ammonia (see *ante,* pp. 92 and 181), and creosote. The latter probably combines with albumen.

It can scarcely be doubted that all the agents of this sub-order become absorbed. Dippel's oil has been detected in the blood and in the breath (see *ante,* pp. 104-106).

The stimulants of this sub-order powerfully influence the functions of the nervous system, whose energy and activity they exalt. According to Vogt,[1] the more volatile the remedy, the more it increases the *activity* of the nervous functions, and the more fixed the more it raises their *energy*. Thus, according to the same writer, the preparations of ammonia raise the activity more than the energy of these functions; the empyreumatic oils somewhat less.

In some disordered conditions of the reflex-spinal functions, they allay spasmodic action (see *ante,* pp. 211-212). In poisonous doses, they rapidly destroy life; acting in the twofold capacity of irritants to the stomach and bowels, and poisons to the nervous system. In moderate doses, they act as stimulants to the mucous surfaces, the skin, and other secreting organs.

The effects of the substances composing this sub-order are very quickly produced, and soon disappear. Consequently, these remedies are adapted to urgent and acute cases when the danger is imminent, and an immediate effect desired: for the same reason they require to be frequently repeated, in order to keep up their effects. From their exciting operation, they are indicated in cases of debility and sinking of the vital powers, and in spasmodic diseases.

---

[1] *Lehrbuch der Pharmakodynamik.* Bd. i. S. 186, 2te Aufl. Giessen, 1828.

The following are some of the cases for which they are employed:—

1. As topical stimulants or acrids.
2. As topical applications in skin diseases; such as porrigo, lupus, &c.
3. As stimulants to the heart, blood-vessels, and nervous system, in syncope, in exhaustion from low fevers, or other causes, in collapse, as of cholera, &c.
4. As antispasmodics in hysteria, epilepsy, and angina pectoris.
5. As anthelmintics, especially for tænia.
6. Some of them have been used to allay vomiting, to check the excretion of sugar in diabetes, and to relieve obstinate chronic rheumatism.

SUB-ORDER δ. EXCRETA ANIMALIA.—Animal excretions used as stimulants.

RODENTIA.	RUMINANTIA.
Castor Fiber—*Castoreum.*	Moschus moschiferus—*Moschus.*

These substances are reputed stimulants and antispasmodics. After the internal use of musk, the odour of this substance has been detected in the blood and in the cutaneous transpiration (see *ante*, pp. 104 and 106). The odorous emanations of musk produce, in some sensitive constitutions (see p. 3) headache, and even fainting. Both musk and castoreum are employed in spasmodic affections. Musk is also used in low fevers and retrocedent gout; castoreum in nervous complaints, and as a stimulant to the uterus.

SUB-ORDER ε. PHOSPHORUS.—Phosphorus requires to be placed in a separate sub-order of stimulants, on account of the peculiarity both of its chemical properties and physiological effects.

When swallowed, it operates as an irritant and caustic (see p. 97). It becomes absorbed, and communicates an alliaceous odour to the breath. After its absorption it acts as a stimulant to the nervous, vascular, and secreting organs. It excites the mental faculties and the sexual feelings, raises the temperature of the skin, increases the frequency of the pulse, and promotes the secretions. In large doses it operates as an irritant poison, becomes absorbed, and produces convulsions, insensibility, and death.

The workmen engaged in the manufacture of lucifer matches (especially the dippers) are occasionally liable to necrosis of the jaw-bone.[1] Dr. von Bibra[2] thinks that the deleterious effects are due to hypo-phosphorous acid contained in the atmosphere of the manufactory.

[Phosphorus, like oxygen (see article Oxygen), is capable of assuming the allotropic state; and, when used in that condition for the manufacture of lucifer matches, all the evils above noticed as accruing to those engaged in the works are avoided. Allotropic phosphorus is changed into ordinary phosphorus by friction, so that it answers the purpose of the match-maker quite as well as the ordinary variety, while it *does not emit vapours when exposed to air*. It may be handled freely, and differs in appearance from ordinary phosphorus, being of a red colour. It was formerly described by chemists as an oxide, but has been lately shewn to be nothing else than phosphorus in the masked or allotropic form.—ED.]

---

[1] In these cases, Dr. Letheby (*London Medical Gazette*, vol. iv. N. S. p. 153,) found an unusual quantity of phosphoric acid in the urine.

[2] *Die Krankheiten der Arbeiter in den Phosphorzündholzfabriken, ins besondere das Leiden der Kieferknochen durch Phosphordampfe. Vom chemischphysiologischen, medicinischchirurgischen und medicinischpolizeilichen Standpunkte.* Bearbeitet von Dr. F. E. von Bibra und Dr. L. Geist. Erlangen, 1847. (Reviewed in the *British and Foreign Medico-Chirurgical Review*, No. II. April 1848, p. 446.)

Phosphorus is administered as a stimulant to the nervous centres in convulsive and old paralytic cases, and in low fevers; as an aphrodisiac; and as a cutaneous stimulant in some exanthematous diseases in which the eruption has receded from the skin.

SUB-ORDER ζ. SPIRITUOSA ET ÆTHEREA. *Alcoholica.*—Ardent spirits, wine, beer, and the ethers, are the agents composing this sub-order, which is identical with the Methystica, a group of the Phrenica, whose effects have been already noticed (see *ante*, p. 204).

The physical and chemical action of some of the agents of this sub-order has been before referred to (see *ante*, pp. 91, 92, 98, 99, and 112).

They are employed as powerful and diffusible stimulants in failure of the vital powers. In delirium from exhaustion and inanition they are invaluable; but in delirium from congestion or inflammation of the brain they are injurious.

ORDER 2. SEDANTIA; *Sedativa; Deprimentia.*—By the term sedative I understand an agent which directly diminishes the force of the action of the heart and other organs by repressing the nervous influence.

Sedatives have been confounded with both stimulants and narcotics. The effect of a sedative should be distinguished from the exhaustion which results from over-stimulation: the former is primary and direct; the latter is secondary and indirect. Several of the substances called narcotics act also as sedatives: but all sedatives are not narcotics; for example, emetic tartar. Narcotics may be advantageously combined with either stimulants or sedatives; as opium with brandy or ammonia, or opium with digitalis or emetic tartar. But stimulants and sedatives, as brandy and digitalis, or ammonia and emetic tartar, cannot be expected to produce any useful combined effect.

The following are the substances most frequently employed as sedatives:—

ORGANIC.

RANUNCULACEÆ.
    Aconitum Napellus—*Radix.*
PAPAVERACEÆ.
    Papaver somniferum—*Opium.*
        Morphia.
TERNSTRŒMIACEÆ.
    Thea Bohea—*Folia.*
    " viridis—*Folia.*
AMYGDALEÆ.
    Amygdalus communis—*Amygdalæ amaræ.*
    Cerasus Lauro-cerasus—*Folia.*

UMBELLIFERÆ.
    Conium maculatum—*Folia, Fructus.*
SOLANACEÆ.
    Hyoscyamus niger—*Folia.*
    Atropa Belladonna—*Folia.*
    Nicotiana Tabacum—*Folia.*
SCROPHULARIACEÆ.
    Digitalis purpurea—*Folia.*
MELANTHACEÆ.
    Colchicum autumnale—*Cormus.*

Acidum hydrocyanicum.

INORGANIC.

Antimonii Potassio-Tartras.

The topical action of most of these agents has been already noticed (see pp. 170, 188, 203).

After the absorption of these agents, or their active principles, into the blood, they operate as sedatives to the vascular system; that is, they diminish the force of the heart's action, and reduce the strength, and sometimes the frequency also, of the pulse; but diminution of the frequency of the pulse is neither a constant nor a necessary effect of a sedative.

> "Digitalis and other sedatives sometimes make the pulse quicker than it was before: but every person who has bled a few patients must have observed that the pulse becomes quicker as the patient grows faint. Mere increased frequency of pulse is not, therefore, a proof [that digitalis at first produces a stimulant effect], as no person will call blood-letting to syncope a stimulant."[1]

Digitalis frequently causes an intermittent pulse. In excessive doses some of the sedatives (*e. g.* tobacco, aconite, and digitalis) destroy life by causing paralytic syncope (see *ante*, p. 221).

The effect of sedatives on the other functions is not uniform. Several (*e. g.* emetic tartar and tobacco) produce excessive nausea, depression, and exhaustion. Some (*e. g.* colchicum and emetic tartar) purge; others (*e. g.* morphia) cause constipation.

The effects of aconite and hyoscyamus have been already alluded to (see *ante*, pp. 207, 208). Digitalis acts as a diuretic.

The manner in which some of these agents cause death has been before noticed (see *ante*, p. 220).

Sedatives are employed to reduce the force of the vascular system in acute inflammation and inflammatory fever. For this purpose emetic tartar, or sometimes colchicum, is used; also to tranquillize the action of the heart, and to allay the excessive irritability of the nervous system, when not dependent on anæmia or extreme debility. For this purpose the narcotic sedatives are frequently used. Likewise to control irregularities of the circulation. To allay palpitation, hydrocyanic acid, digitalis, and aconite, are sometimes used with advantage. Belladonna plaster is frequently employed for the same purpose.

2. *Affecting the alimentary canal.*—The ganglionics which affect the alimentary canal are of three kinds:—

α. Some affect the movements of the alimentary canal. Those which promote and quicken them are denominated purgatives, and will be noticed hereafter (see *Class* VIII. *Eccritica*). Others lessen the peristaltic movements and relieve spasm (see *Paralytica*, p. 217). Of these the most powerful is opium (see *Meconica*, p. 206).

Some relieve pain in the alimentary canal (see *Anæsthetica*, p. 208).

γ. Some affect the secretions of the alimentary canal (see *Class* VIII. *Eccritica*).

Class VIII. *Cœlinca.* Medicines acting on the Digestive Organs.

Medicines which act on the digestive organs may be termed *cœliaca* (κοιλιακά; from κοιλία, *the belly*). They may be divided into five orders,—those affecting the alimentary canal (*enterica*); those affecting the salivary glands (*sialica*); those affecting the liver (*hepatica*); those affecting the spleen (*splenica*); and those affecting the pancreas (*pancreatica*).

ORDER 1. ENTERICA (ἐντερικά; from ἔντερον, *the bowels*).—Agents which affect the alimentary canal. Most of the agents belonging to this order either have been already noticed or will be more conveniently considered hereafter under other heads.

---

[1] *First Principles of Medicine*, by Arch. Billing, M.D. A.M. p. 81, 4th edit. 1841.

α. The enterica employed as *stomachics* and *carminatives* have been before noticed under the order *Stimulantia* (see *ante*, p. 222).

β. The enterica which are used to allay thirst (*adipsa*) have been already considered under the order *Spanæmica* (see *ante*, p. 174).

γ. The enterica which are administered to promote the appetite belong to the *tonica* (see *ante*, p. 211).

δ. The enterica which affect the movements of the alimentary canal have already been incidentally alluded to (see *ante*, p. 218); but, as most of them also affect the secretions of the gastro-intestinal surface, they will be specially noticed hereafter under the class *Eccritica*.

ε. The enterica which are employed to allay pain of the alimentary canal are *anæsthetica*, before noticed (see p. 208).

ζ. The enterica which affect the secretions of the gastro-intestinal mucous membrane will be hereafter described (see *Class* VIII. *Eccritica*).

η. Some enterica destroy, counteract, neutralize, or expel morbific substances contained in the alimentary canal. To this division belong the agents called *antidotes*, employed in cases of poisoning (see *ante*, pp. 158 and 163); chemical agents administered to relieve dyspeptic acidity or alkalinity of the gastro-intestinal fluids (see *ante*, pp. 178 and 182); and *anthelmintics*, employed to expel intestinal worms. Of these the latter alone require special notice here.

SUB-ORDER ANTHELMINTHICA; from ἀντί, *against*, and ἕλμινς, *a worm*); *Helminthagoga*; *Vermifuga* (from *vermis*, a worm, and *fugo*, I expel). Anthelmintics are agents which cause the destruction or expulsion of intestinal worms. There are five entozoa inhabiting the human intestinal canal, and to which the name of intestinal worms is given. Of these, three species possess an alimentary canal, and are, therefore, called hollow worms, or *Cœlelmintha* (from κοῖλος, *hollow*, and ἕλμινς, *a worm*), while the other two have no true abdominal cavity, and are in consequence called solid worms, or *Sterelmintha* (from στερεός, *solid*, and ἕλμινς, *a worm*).

CŒLELMINTHA.	STERELMINTHA.
Les intestinaux cavitaires (*Cuvier*). Entozoa nematoïdea (*Rudolphi*).	Les intestinaux parenchymateux (*Cuvier*).
1. *Tricocephalus dispar*, or Long Thread-Worm. Found in the cæcum and large intestine.	1. *Tænia Solium*, or Common Tape-Worm. Found in the small intestines of the English, Dutch, and Germans.
2. *Ascaris lumbricoides*, or Large Round-Worm. Found in the small intestine.	2. *Bothriocephalus latus*, or Broad Tape-Worm. Found in the small intestines of the Swiss and Russians.
3. *Ascaris*[1] *vermicularis*, or Small Thread-Worm. Found in the rectum.	

In English medical practice three only of these come under our notice for treatment; for it does not appear that the long thread-worm excites any morbid symptoms, and the broad tape-worm does not inhabit the bowels of our countrymen.

---

[1] Those helminthologists who have failed to detect in this animal the three valvular papillæ characteristic of the genus *Ascaris*, refer the species to the genus *Oxyuris* (see the article *Entozoa*, by Professor Owen, in the *Cyclopædia of Anatomy and Physiology*).

A considerable number of substances have been considered to possess anthelmintic properties. The following is a list of the chief of them :—

VEGETABLE.

- RANUNCULACEÆ.
  - Helleborus niger—*Radix.*
  - Helleborus fœtidus—*Folia.*
- GUTTIFERÆ.
  - Garciniæ species incerta—*Cambogiæ gummi-resina.*
- MELIACEÆ.
  - Melia Azedarach—*Cortex radicis.*
- RUTACEÆ.
  - Ruta graveolens—*Folia, oleum.*
- SIMARUBACEÆ.
  - Picræna excelsa—*Lignum.*
- LEGUMINOSÆ.
  - Andira inermis—*Cortex* (*Geoffroyæ*).
  - Mucuna pruriens—*Leguminum setæ.*
  - Cassia ; plurimæ species—*Sennæ folia.*
- ROSACEÆ.
  - Brayera anthelmintica — *Cacumina et flores* (*Kousso*).
- AMYGDALEÆ.
  - Persica vulgaris—*Folia.*
- MYRTACEÆ.
  - Melaleuca minor—*Oleum* (*Cajuputi*).
- CUCURBITACEÆ.
  - Cucumis Colocynthis—*Fructus pulpa.*
- UMBELLIFERÆ.
  - Narthex Assafœtida—*Gummi-resina.*
- VALERIANACEÆ.
  - Valeriana sylvestris— *Radix.*
- COMPOSITÆ.
  - Tanacetum vulgare—*Herba, semina, flores, oleum.*
  - Artemisia Absinthum—*Herba, oleum.*
  - Artemisia Santonicum—*Cacumina* (*semen santonicum*).
- OLEACEÆ.
  - Olea Europæa—*Oleum.*
- SPIGELIACEÆ.
  - Spigelia Marilandica—*Radix.*
- CONVOLVULACEÆ.
  - Convolvus Scammonia—*Gummi-resina.*
  - Exogonium Purga—*Radix* (*Jalapæ*).
- SOLANACEÆ.
  - Nicotiana Tabacum—*Folia.*
- CHENOPODIACEÆ.
  - Chenopodium anthelminticum—*Fructus.*
- LAURACEÆ.
  - Camphora officinarum—*Camphora.*
- EUPHORBIACEÆ.
  - Ricinus communis—*Oleum.*
  - Croton Tiglium—*Oleum.*
- JUGLANDACEÆ.
  - Juglans regia—*Cortex nucum.*
- CONIFERÆ.
  - Pinus; plurimæ species—*Oleum Terebinthinæ.*
  - Juniperus Sabina—*Folia, oleum.*
- LILIACEÆ.
  - Allium sativum—*Bulbus.*
  - Aloë ; plurimæ species—*Succus concretus.*
- MELANTHACEÆ.
  - Asagræa officinalis—*Semina* (*Cebadilla*).
- FILICES.
  - Nephrodium Filix mas—*Rhizoma, oleum.*
- ALGÆ.
  - Gigartina Helminthocorton.

Acetum.

ANIMAL.

Oleum animale Dippelii.
Oleum Cornu cervi empyreumaticum.

MINERAL.

Hydrargyrum,
Hydrargyri bichloridum.
Hydrargyri chloridum.
Stannum—*Pulvis.*
Ferrum—*Limatura.*
Ferri sulphas.
Ferri sesquichloridum.
Acidum arseniosum.
Antimonii potassio-tartras.
Calx—*Aqua calcis.*
Sodii chloridum.
Potassæ sulphas.
Aqua (frigida).
Petroleum.

Considered with regard to their *modus operandi,* anthelmintics are of two kinds :—

1. Some act obnoxiously on intestinal worms—destroying or injuring them. These are the anthelmintics properly so called ; the anthelmintic specifics ; or the *vermicides* of some authors. Some of these agents, as powdered tin and cowhage, operate mechanically (see *ante,* p. 159) ; others act either chemically or dynamically, as oil of turpentine.

2. Some agents prove anthelmintic in consequence of their operation on the bowels : these are the cathartic anthelmintics or *vermifuges ;* such as calomel, jalap, scammony, and gamboge.

Some writers admit another class of anthelmintics, namely agents " which increase the tone of the digestive organs, and thereby obviate that condition of the stomach and bowels which appears to favour the generation and nourishment of these animals."[1]

The best anthelmintic prophylactics are—wholesome food and the use of purgatives, if the bowels be costive, and of bitter or ferruginous tonics if debility exist.

The circumstances which favour or check the production of intestinal worms are imperfectly understood; and the assumption that their formation is referable to a debilitated state of the alimentary canal is entirely hypothetical. Some persons appear to be constitutionally disposed to their production. Negroes seem to be more liable to them than the white races.

In the treatment of helminthiasis it is generally advisable to employ both cathartics and the anthelmintic specifics. The first aid the expulsion of the worms in at least two ways;—mechanically, and by preventing the accumulation of intestinal mucus. Some cathartics may also act as poisons to the worms.

The following was Bremser's favourite anthelmintic, and which he states that he used for many years with the greatest success against all species of intestinal worms:—

℞ Seminum Santonici (vel seminum seu florum Tanaceti) contusorum	℥ss.
Pulveris Valerianæ	ʒij.
Pulveris Jalapæ	ʒjss.—ʒij.
Potassæ Sulphatis	ʒjss.—ʒij.
Oxymellis Scillæ	q.s. ut fiat electuarium.

Two or three spoonfuls to be taken daily.

Anthelmintics are administered both by the mouth and by the rectum. When the worms are contained in the small intestine (as the large round worm and the tape-worm) they should be given by the mouth; but for worms in the rectum (as the small thread worm) anthelmintic enemata are preferable. "To introduce at one end of a tube, several yards long, substances which are intended to act upon animals that live quite at its other end, would be a very round-about course."[2]

Each kind of parasite has been supposed to require its particular mode of treatment. It may be useful, therefore, to notice successively the remedies which have gained the most repute for each species of worms.

1. *Treatment for Thread-Worm* (Ascaris vermicularis).—As these animals usually inhabit the rectum, they are best treated by clysters.[3] These may consist of ice-cold water, vinegar and water, salt and water, infusion of quassia with or without common salt in solution, lime water, solution of sulphate of iron, solution of sesquichloride of iron (half an ounce of the tincture of sesquichloride of iron to half a pint of water), decoction of aloes, assafœtida mixture, castor oil (in gruel or any other simple vehicle), oil of turpentine, or infusion of senna.

The preceding are safe enemata. Injections of tobacco infusion, and solutions of arsenic and corrosive sublimate, have been recommended; but they are highly dangerous and, I believe, unnecessary.

A solution of a table-spoonful of common salt in cold water, or in infusion of quassia, usually proves a most effective anthelmintic enema. Where this fails, a turpentine clyster may be had recourse to. For children, one to four drachms; for adults, one or two ounces, of this oil may be administered mixed with gruel.

---

[1] Eberle, *A Treatise of the Materia Medica*, 2d edit. vol. i. p. 147. 1824.

[2] Watson's *Lectures on the Principles and Practice of Physic*, vol. ii. p. 505.

[3] "Thread-worms may be scooped out of the rectum with the finger. Old women fish for them with a piece of fat meat, or candle, wherewith the entangled worms are drawn out of the bowel" (Watson, *op. cit.*)

The intolerable itching which thread-worms give rise to is frequently allayed by enemata of olive oil. Dr. Watson states that it may be quieted by applying a towel, wetted with cold water, to the fundament, while in bed.

Brisk cathartics should be from time to time administered by the mouth.

The thread-worm is sometimes found in the cæcum. In this case it is obvious that enemata must fail in removing them. We must then administer our remedies by the mouth. Besides the use of cathartics, bitters (quassia, semen santonicum, tansy, &c.) and chalybeates (sulphate or tincture of sesquichloride of iron), or, where these fail, oil of turpentine may be had recourse to.

2. *Treatment for the Long Thread-Worm* (Tricocephalus dispar).—This worm is not known to produce any morbid symptoms; and remedies for it, therefore, are not likely to be required. Should its presence in the bowels be unequivocally ascertained (as by the patient's voiding some of these entozoa by stool), the same treatment may be adopted as for the small thread-worm when seated in the cæcum.

3. *Treatment for the Long Round Worm* (Ascaris lumbricoides).—This species of parasite is best treated by active evacuants, and in the intervals of their use by some of the specific anthelmintics.

A mixture of calomel and jalap forms a good purgative. Where calomel is objectionable, a mixture of jalap, scammony, and gamboge, may be substituted; or, in some cases, a mixture of jalap and rhubarb. I have frequently found the compound infusion of senna, with an occasional dose of calomel, very effectual.

Bradley[1] recommends the use of antimonial or ipecacuanha emetics. When the worms are contained in the stomach or upper part of the small intestines, the use of emetics undoubtedly proves very serviceable.

The specific anthelmintics which have been recommended for this species of worm are very numerous, though few of them, I suspect, are employed in this country at the present time. Tin powder, cowhage, pink root (*Spigelia*), and cabbage tree bark (*Andira*), have been much celebrated. The mode of using them will be hereafter noticed. Bitters (as quassia) and chalybeates (sulphate and tincture of sesquichloride of iron) are frequently employed, and with benefit. Oil of turpentine sometimes proves effective, but less frequently so than in tape-worm. For adults Bradley recommends bichloride of mercury and arsenious acid. Assafœtida, garlic, camphor, and fetid hellebore, are other remedies which have been employed.

4. *Treatment for Tape-Worm* (Tænia Solium and Bothriocephalus latus).—For the tape-worm we use a combination of purgatives and vermicides.

The most successful remedy for tape-worm is oil of turpentine. It should be given in full doses: for an adult from six drachms to an ounce and a half; for a child from half a drachm to two or three drachms. It should be given so that it may pass through the bowels rapidly without becoming absorbed; and thus, by coming in contact with the worm, destroy it. To fulfil these objects it should be taken in the morning fasting, and, to ensure its purgative effect, an equal quantity of castor oil should be given, either in conjunction with it or within a few hours after it.

---

[1] *A Treatise on Worms*, by T. Bradley, M.D. Lond. 1813.

The objections to the use of oil of turpentine are—its nauseous flavour, its being apt to cause vomiting, and the brain disorder (a kind of intoxication) and irritation of the urinary organs, which it sometimes excites. I have known it to produce bloody urine for several days after its employment.

Where the oil of turpentine fails, or where, from the disagreeable character of its effects, its use cannot be persevered in, other anthelmintics must be resorted to.

Male fern oil, and also the rhizome (Madame Nouffer's specific), cevadilla, which Schmucher considered to be infallible, the bark of the root of the pomegranate, tin filings, walnut shells, petroleum, and Chabert's empyreumatic oil, are celebrated anthelmintics for this species of intestinal worm.

Chabert's empyreumatic oil (*oleum empyreumaticum Chaberti*) is prepared by mixing one part of the empyreumatic oil of hartshorn with three parts of oil of turpentine, and submitting the mixture to distillation in a glass retort until three-fourths have passed over. The dose of the distilled product is two teaspoonfuls in water night and morning. This remedy is to be continued until four or five, or even six or seven, ounces have been taken;—a cathartic being from time to time exhibited.

The Kousso or Kosso (see *ante*, p. 229) has been lately used with beneficial effect in the London Hospitals, in cases of tænia.

ORDER 2. HEPATICA (ἡπατικά; from ἧπαρ, *the liver*). Medicines which affect the liver and its appendages.—These agents either have been already noticed or will more conveniently be considered hereafter.

α. The hepatica which affect the secretion or excretion of bile will be noticed hereafter (see *Class* VIII. *Eccritica*).

β. The hepatica which relieve pain of the liver, gall-bladder or gall-ducts, are the *anæsthetica* before mentioned (see p. 208). Opium or morphia is the only remedy to be relied on.

γ. The hepatica employed to relieve spasm of the gall-ducts, as in the passage of biliary calculi, are the *paralytica* already noticed (see p. 217). Opium or morphia is our sheet-anchor.

δ. The hepatica administered with the view of modifying the nutrition of the liver, and thereby of relieving enlargements and other organic maladies of this organ, are the *spanæmica resolventia* which have been before noticed (see p. 179).

ORDER 3. SPLENICA (σπληνικά; from σπλήν, *the spleen*). Medicines which affect the spleen.

The number of medicinal agents which appear to exercise a specific influence over the spleen are few in number. The chief are the *chalybeates* and *quina*, and to these, perhaps, should be added *iodine*, *bromine*, and *mercurials*.

The influence of these agents over the spleen is inferred chiefly from the effects which they have been observed to produce in simple enlargement of the spleen. The beneficial effects of the chalybeates in these cases have been before alluded to (see *ante*, p. 197). According to Piorry[1] quina diminishes the volume of the spleen, and in this way cures ague.

---

[1] *Traité de Médecine pratique*, t. vi. p. 123, Paris, 1845.

According to Piorry the spleen is enlarged in every ague, whatever the type (whether quotidian, tertian, or quartan); and the augmentation is larger during the paroxysm than in the intermission. The salts of quina diminish the volume of the spleen, and cure ague; they are, therefore, febrifuges *par excellence*. The more soluble they are, the more rapidly do they act; and the larger the dose, the more marked are their effects. Their action on the spleen, however, is over in about half an hour after their use; and their curative power, as febrifuges, is in proportion to their effect on its size. M. Piorry states that he has been enabled to ascertain these circumstances by means of mediate percussion of the spleen before and after the use of quina in agues: his observations, however, have not been confirmed by others.

The effects of iodine and bromine in enlargement of the spleen have been already alluded to (see *ante*, pp. 186-187). With regard to the effect of mercury on the spleen, Dr. Abercrombie[1] observes that "it is now generally admitted that, in the treatment of enlarged spleen, mercury is uniformly and highly injurious, producing mortification of the mouth and rapid failure of the strength."

The *spleen powder* and *spleen mixture*, used in Bengal in enlargements of the spleen, are combinations of rhubarb, jalap, scammony, and cream of tartar, with calumba powder and sulphate of iron, taken three times a day, in such doses as to keep up regular but moderate purging. About twenty days are stated by Mr Twining[2] as the period which is generally required for reducing by this treatment a very considerable tumefaction of the spleen, if the case has been recent. Some persons employ nitric acid with regular aloetic purges.

ORDER 4. SIALICA ET PANCREATICA.—Medicines which affect the salivary glands are denominated *sialica* (σιαλικά from σίαλον, *the saliva*); while those which affect the pancreas are termed *pancreatica* (from πανκρεας, *the pancreas*). It is probable, however, that medicinal agents which affect the former also influence the latter organ.

As these agents are employed only for influencing the secretions of these organs, they will be noticed hereafter (see *Class* VIII. *Eccritica*).

Class VIII. *Eccritica.* Medicines acting on the Excernent System.

Medicines which affect the functions of the excernent system are termed *eccritica* (ἐκκριτικά; from ἔκκρισις, *secretion*).

By their influence over the process of secretion, they may affect the quantity (either increasing or diminishing it), or the quality, or both, of the secreted product. Accordingly, the eccritica are employed in medicine for the threefold purpose of augmenting, lessening, or altering the secretions.

1. *Augmenting secretion.*

(Evacuantia.)

In most cases the influence of the eccritica which augment secretion is topical; in some cases, perhaps, it may be remote.

Their topical influence is direct in the case of masticatories, errhines, and cathartics which are applied immediately to the secreting organ. It is indirect in the case of diuretics, expectorants, and sudorifics, whose active principles are absorbed by the parts to which they are applied, and carried by the blood to the secreting organs (see *ante*, p. 113).

---

[1] *Pathological and Practical Researches on Diseases of the Stomach, the Intestinal Canal, the Liver, and other Diseases of the Abdomen*, p. 412, 2d edit. Edinb. 1830.

[2] *Transactions of the Medical and Physical Society of Calcutta*, vol. iii. p. 351.

In some cases, perhaps, the influence of an evacuant over a secreting organ may be remote; that is, may be exercised through the agency of the nerves.

The evacuating eccritica are used for various purposes, of which the following are the most important:—

α. To restore the natural secretion of a part when its diminution or stoppage results from torpor or deficient vascular activity of the secreting organ.

β. To augment the natural secretion of a part, and thereby to diminish the quantity of circulating fluid (see *ante*, p. 173).

γ. To augment the natural secretion of a part, and thereby to promote absorption—as in dropsy.

δ. To augment the secretion of one part, and thereby to lessen the secretion of some other part[1] (see *ante*, pp. 129-130).

ε. To augment the secretion of an organ, and thereby to relieve local determinations of blood to remote parts; as when we administer purgatives to relieve determination of blood to the brain (see *ante*, pp. 128-129).

ζ. To promote secretion, and thereby to favour the subsidence of diseases whose natural termination is by increased secretion.

η. To produce exhaustion (the secondary effect of evacuants), and thereby to act as antiphlogistics.

ORDER 1. ERRHINA, ἔρριvα; from ἐν, *in*, and ρίν, *the nose*).—Medicines which are introduced into the nose, usually for the purpose of producing an increased discharge of nasal mucus, are called *errhines*. When they are employed to excite sneezing they are termed *sternutatories* (*sternutatoria*; from *sternuo*, I sneeze) or *ptarmics* (*ptarmica*; πταρμικα, from πταίρω, *I sneeze*).

Most foreign matters, especially acrid substances, when applied to the membrane lining the nostrils, provoke an increased mucous secretion; and, when snuffed up in the form of powder, usually act as sternutatories. The following are the officinal substances used as errhines:—

1. VEGETABLE.

SOLANEÆ.
  Nicotiana Tabacum—*Folia*.
LABIATÆ.
  Hyssopus officinalis—*Herba*.
  Lavandula vera—*Flores*.
  Marrubium vulgare—*Herba*.
  Melissa officinalis—*Herba*.
  Mentha Pulegium—*Herba*.
    " viridis—*Herba*.
    " Piperita—*Herba*.
  Origanum Majorana—*Herba*.
    " vulgare—*Herba*.
  Rosmarinus officinalis—*Herba*.
  Salvia officinalis—*Herba*.
  Teucrium Chamædrys—*Herba*.
    " Marum—*Herba*.
ARISTOLOCHIÆ.
  Asarum Europæum—*Herba*.
EUPHORBIACEÆ.
  Euphorbia —— (?)—*Resina*.
MELANTHACEÆ.
  Veratrum album—*Cormus*.
GRAMINACEÆ.
  Saccharum officinarum—*Saccharum*.

2. INORGANIC.

Sodii chloridum.
Ammonii chloridum.
Hydrargyri disulphas.

---

[1] "Since all secretions, inasmuch as they extract certain ingredients from the blood, produce a change in its composition, no one secretion can be altered in quantity or quality without disturbing the balance which exists between all in their action on the blood; hence, the increase of one secretion gives rise to the diminution of another." (Müller's *Physiology*, by Baly, vol. i. p. 473.)

Errhines are local irritants: some of them act mechanically, others chemically or dynamically.

Some medicines, as iodide of potassium, when administered by the mouth, become absorbed, and subsequently augment the nasal secretion. Such agents are not usually called errhines, because they are not applied directly to the pituitary membrane.

Errhines cause augmented secretion of nasal mucus, frequently excite sneezing, and, by long-continued use (as in the case of snuff), thicken the mucous membrane, blunt the sense of smell, and alter the tone of the voice.

Sneezing is a reflex-spinal act (see *ante*, p. 218). The incident or excitor nerve, by which the impression is conveyed to the nervous centre, is the nasal branch of the trifacial.

By repeated use errhines lose their power of exciting sneezing: at least this is well known to be the case with regard to snuff.

Dr. Hall[1] states that "actual sneezing may frequently be prevented, after the inspiration by which it is usually preceded has occurred, by forcibly rubbing the end of the nose."

Absorption readily takes place from the pituitary membrane. I have several times experienced the constitutional effects of tobacco (such as nausea, giddiness, depression of the muscular power, and disorder of the mental functions), from the use of the moist snuffs (*rappees*), especially Barbary snuff.

Considered with regard to their modus operandi, errhines may be divided into two principal groups:—

1. Those which act mechanically, as sugar.

2. Those which act chemically or dynamically as well as mechanically. This group includes the aromatic errhines of the natural order Labiatæ; the acrid errhines, such as euphorbium, veratrum, and asarum (the most powerful errhines of the order); the sedative errhine, tobacco; and, lastly, the inorganic errhines.

Errhines have been principally employed to relieve chronic affections of the eyes, face, and brain; for example, chronic ophthalmia, amaurosis, headache, &c. They can only be useful on the principle of counter-irritation (see *ante*, p. 127). In syphilitic affections of the nose, and where there is a disposition to nasal polypus, the frequent use of errhines may perhaps be injurious.

Schwilgué[2] enumerates the following purposes for which sneezing is excited:—to excite respiration when this function is suspended; to promote the expulsion of foreign bodies accidentally introduced into the air-passages; to occasion a general shock at the commencement of dangerous diseases which we wish at once to suppress; to augment the secretion of nasal mucus and of tears; to favour the excretion of mucus collected in the nasal sinuses; to exalt the action of the encephalon, of the senses, of the uterus, &c.; and to stop a convulsive or spasmodic state of the respiratory apparatus. We should not, however, forget that the concussion occasioned by sneezing is not always free from dangerous results, especially in plethoric habits and persons disposed to apoplexy or affected with hernia, prolapsus of the uterus, &c.

ORDER 2. EXPECTORANTIA (from *ex*, out of, and *pectus*, the breast).—Medicines which promote the evacuation of mucus and other secreted matters from the bronchia, trachea, and larynx, are called *expectorants*.

---

[1] *On the Diseases and Derangements of the Nervous System*, p. 99, 1841.

[2] *Traité de Matière Médicale*, t. ii. p. 298.

Medicines which alleviate cough are called *bechics* (*bechica ;* βηχικά, from βήξ, *a cough*), or *cough-medicines* (*tussicularia* vel *tussiculosa*). The substances used as such are commonly demulcents (see *ante*, p. 171), cerebro-spinals, (see *ante*, p. 204), and expectorants.

The term expectorant is usually applied to agents which increase or promote the secretion of bronchial mucus. It has also been applied to medicines which aid the evacuation (expectoration) of the already secreted bronchial mucus (*i. e.* to medicines which excite cough); to medicines which alter the quality of the bronchial mucus, and, by rendering it thinner and less viscid, assist the patient in bringing it up; and, lastly, to medicines which check very profuse secretion, and thereby enable the patient more easily to expectorate that which is produced.

The substances usually supposed to promote the secretion of bronchial mucus may be divided into two kinds: those which produce their effect by direct application to the bronchial membrane, and those which are administered by the stomach, and require to be absorbed before they act as expectorants.

The following list of expectorants is, with few exceptions, that drawn up by the late Dr. Duncan.[1]

1. TOPICAL.

Applied in the form of liquid to the fauces :—

Emollients and Demulcents in general.

Applied in the form of gas or vapour to the mucous membrane of the lungs :—

Nicotiana Tabacum—*Folia.*
Datura Stramonium—*Herba.*
Myrrha.
Pix liquida.
Olea volatilia.
Aqua.
Alcohol.
Ætherea.
Acidum benzoicum.
" aceticum.
Acidum sulphurosum.
Ammonia.
Ammoniæ carbonas.
Chlorinium.
Iodinium.

2. GENERAL.

Taken into the stomach and acting through the circulation :—

VEGETABLE.

- POLYGALACEÆ.
  - Polygala Senega—*Radix.*
- TEREBINTHACEÆ.
  - Balsamodendron Myrrha—*Gummi-resina.*
- LEGUMINOSÆ.
  - Copaifera; plurimæ species—*Oleo-resina.*
  - Myrospermum peruiferum—*Balsamum.*
- UMBELLIFERÆ.
  - Galbanum officinale—*Gummi-resina.*
  - Narthex Assafœtida—*Gummi-resina.*
  - Ferula——(?)—*Gummi-resina* (*Sagapenum*).
  - Dorema Ammoniacum—*Gummi-resina.*
- CINCHONACEÆ.
  - Cephaëlis Ipecacuanha—*Radix.*
- STYRACEÆ.
  - Styrax Benzoin—*Balsamum.*
  - " officinale—*Balsamum.*
- LILIACEÆ.
  - Urginea maritima—*Bulbus* (*Squill*).
  - Allium sativum—*Bulbus.*

INORGANIC.

Antimonii potassio-tartras.

Of all the classes of the Materia Medica none are more uncertain in their operation than expectorants. Most of the agents employed as such act relatively; that is, they obviate the causes which interfere with healthy secretion. Many of them are substances which modify the vital activity of the aërian membrane by an alterative influence, and in this way relieve bronchial affections, expectoration being by no means an essential part of their operation.

---

[1] *Supplement to the Edinburgh New Dispensatory.* Edinburgh, 1829.

The topical expectorants are of two kinds; some are emollients and demulcents, others are local stimulants. To the former belong not merely the liquids applied to the fauces, but also warm aqueous vapour when inhaled, and in that way applied to the bronchial membrane.

The general expectorants are also of two kinds—some being stimulating, others nauseating and relaxing. Probably all the stimulating expectorants act topically, after absorption, on the bronchial membrane with which they are brought into contact by means of the blood. Some of them, as garlic and assafœtida, have been detected by their odour in the breath (see *ante*, p. 106). Emetina (and, consequently, ipecacuanha) and emetic tartar have, according to Magendie[1] and Orfila,[2] a specific influence over the lungs, which organs, in animals killed by these substances, are said to present traces of inflammation and congestion.

Expectorants, unlike several other orders of evacuants, are exclusively employed in maladies of the secreting organ on which they operate. The emollient and nauseating (emetic tartar and ipecacuanha) expectorants are adapted for the more acute forms of bronchial irritation and inflammation; the stimulating expectorants for the more chronic forms. Senega is a most valuable remedy in the latter stages of acute inflammation of the lungs and bronchial membrane. The fetid gums, especially assafœtida, are more particularly adapted for the subacute and chronic forms of bronchitis accompanied with spasm of the muscular fibres of the bronchi, and which is so commonly observed in those whose bronchial tubes and cells are dilated.

Irritating gases and vapours (as chlorine, the vapour of acetic or of benzoic acid, &c.) when inhaled, produce coughing, as well as an augmentation of secretion. "We provoke coughing," says Schwilgué,[3] "to favour the expulsion of foreign bodies introduced from without into the aërian tube, and especially of liquids. We have recourse to it to favour the expectoration of mucus, of membraniform concretions, and of pus, which have accumulated in the aërian passages, whenever the local irritation is not sufficiently great."

ORDER 3. EMETICA (ἐμετῖκά; from ἐμέω, *I vomit*); *vomitoria*; *anacathartica* (ἀνακαθαρτικά; from ἀνακαθαιρω, *I cleanse or purge upwards: i. e.* by vomiting [or by expectoration ?]).—Medicinal agents which are used for the purpose of promoting vomiting are called *emetics* or *vomits:* when they merely excite nausea, they are termed *nauseants* (*nauseantia*).

The number of medicinal substances capable of exciting vomiting is very great; but only a few of them are in common use. Their operation is promoted by repletion of the stomach, especially with tepid liquids; and by titillation of the fauces, and especially the velum pendulum palati.[4]

The following is a list of officinal emetics:—

---

[1] *Formulaire.*

[2] *Toxicologie Générale*, t. i. p. 482, 4me éd. 1843.

[3] *Traité de Matière Médicale*, tom. ii. p. 296.

[4] When we titillate, by means of a feather or pen, the throat, to excite vomiting, care must be taken not to carry the feather so far back as to irritate the posterior part of the pharynx; for, in that case, we excite an act of deglutition instead of that of vomiting. A feather, introduced into the throat to excite vomiting, has, by being pushed too far down, been actually swallowed, without causing vomiting. (See *Medical Observations and Inquiries*, vols. iii. and iv.; and also, Dr. Marshall Hall, *On the Diseases and Derangements of the Nervous System*, p. 81.)

1. VEGETABLE.

Cruciferæ.
  Sinapis nigra—*Seminum pulvis.*
Cinchonaceæ.
  Cephaëlis Ipecacuanha—*Radix.*
Compositæ.
  Anthemis nobilis—*Flores.*

Solanaceæ.
  Nicotiana Tabacum—*Folia.*
Aristolochiaceæ.
  Asarum Europæum—*Folia.*
Liliaceæ.
  Urginea maritima—*Bulbus* (*Squill*).

2. INORGANIC.

Antimonii potassio-tartras. | Zinci sulphas. | Cupri sulphas.

Usually, within twenty or thirty minutes after taking an emetic a general feeling of uneasiness and nausea comes on. The pulse becomes small, feeble, and irregular; the face and lips grow pale; a distressing sensation of relaxation, faintness, and coldness of the whole system is experienced; the saliva flows copiously from the mouth; the eyes lose their lustre; and the whole countenance appears dejected. These symptoms, which constitute the first stage of vomiting, continue for a variable period, and are followed by the ejection of the contents of the stomach.

As soon as actual vomiting commences, the general phenomena are altered: the pulse becomes frequent and full, the temperature of the body increases, and a sweat breaks out on the face and other parts. During the act of vomiting, in consequence of the pressure made on the abdominal aorta, and the interruption to the circulation through the lungs, from the impeded respiration, the blood returns with difficulty from the head, the face swells and becomes coloured, the conjunctiva is turgid and red, the jugular veins are gorged, and tears burst from the eyes. The violent straining is often attended with pain in the head and eyes, and with the involuntary expulsion of the urine and fæces. The matters vomited vary according to circumstances: they may consist of the alimentary substances, bile, &c. contained in the stomach and duodenum previous to the exhibition of the emetic; of the fluids collected by the action of the emetic; and, lastly, of the emetic itself. Sometimes striæ of blood are observed, which usually come from the pharynx. The number of vomitings, and the ease with which they are effected, are liable to considerable variation, arising from the state of the digestive organs, the temperament of the patient, the state of the cerebral functions, &c.

When the vomiting has entirely ceased, the patient feels languid, oppressed, and drowsy, and the pulse becomes weak and slow: the exhaustion is sometimes so great as to be attended with fatal consequences. A case of this kind is alluded to by Dr. Paris,[1] in which an emetic was imprudently given to a patient in the last stage of phthisis,[2] with the intention of dislodging the pus with which the lungs were embarrassed: syncope was produced, from which the patient never recovered. Among other occasional ill consequences of vomiting may be mentioned comatose affections, uterine or pulmonary hemorrhages, hernia, abortion, suffocation, prolapsus of the uterus, rupture of the abdominal muscles, &c. These effects are produced by the violent muscular exertions which attend the act of vomiting. They suggest cautions as to the use of emetics. Thus, in apoplexy, and some other cerebral affections, or when a tendency thereto exists; in pregnancy, especially when miscarriage is threatened; in prolapsus uteri, hernia, aneurism, &c. the danger to be apprehended from emetics is obvious. The concussion which they excite sometimes dislodges gall-stones.

---

[1] *Pharmacologia*, 9th ed. p. 204, 1843.

[2] "Consumptive persons ought not to be purged by a vomit." (Hippocrates, *Aphorisms*, Sect. 4, Aph. viii.)

The intensity and duration of the different stages of vomiting have no necessary relation to each other. Thus the sulphates of zinc and copper excite speedy vomiting, with but little nausea; while tobacco and tartarized antimony, on the other hand, produce great nausea and depression of system. Hence, when the depressing effects of emetics are required, as in inflammatory and other diseases, we employ the last-mentioned emetic.

Vomiting is a reflex-spinal act. "In vomiting excited through the fauces, it is the trifacial which is the nerve of transmission; in vomiting induced by an emetic, by a renal calculus, or a gall-stone, it is the pneumogastric;[1] and in the vomiting of early pregnancy or dysmenorrhœa, it is a spinal nerve which is the incident excitor nerve. All these nerves convey the excitement ultimately to the medulla oblongata. This combines the action of the nerves which regulate the aperture of the cardia, the closure of the larynx, and the acts of expiration."[2]

The author just quoted gives the following short summary of the mechanism of vomiting:—"During the act of vomiting,—1, the larynx is closed; 2, the cardia is opened; and 3, all the muscles of expiration are called into action; but 4, actual expiration being prevented by the closure of the larynx, the force of the effort is expended upon the stomach, the cardia being open, and vomiting is effected."

The irritation produced by the exhibition of emetics gives rise to an increased secretion from the mucous follicles of the stomach and duodenum; as is shown by the thick, filamentous, and viscid matters frequently ejected. We infer, also, that the action of the exhalants must be increased, inasmuch as persons who have taken only a few spoonfuls of emetic liquids sometimes bring up a very considerable quantity of fluid. Darwin mentions a man who vomited six pints of liquid, although he had only swallowed one. Bile is frequently thrown up, either alone or mixed with other fluids; but we must not infer from this that it had existed in the stomach previous to the exhibition of the emetic, for bile is not ordinarily rejected in the first efforts, but only in the subsequent vomitings; and the quantity increases in proportion to the length of time the vomiting continues. Emetics promote the secretion of bile, and probably of the pancreatic juice also. We presume that they likewise augment absorption during the stage of nausea, previously to the act of vomiting, and when the force of the circulation is reduced.

Of the substances employed as emetics, some (as mustard) appear to act merely as local irritants to the stomach, for they cause vomiting only when they have been swallowed. Others (as emetic tartar), however, may be termed *specific emetics*, since they induce vomiting, not only when they are introduced into the stomach, but also when injected into the veins.

Does emetic tartar, when introduced into the stomach, occasion vomiting by its direct topical action on this viscus, or is absorption necessary to its emetic effect? It is probable that it may act in both ways. Large doses may occasion vomiting by the gastric irritation they excite; but absorption appears to be necessary to the specific emetic effects.

When emetic tartar has entered the circulation (either by absorption or injection into the blood-vessels), does it occasion vomiting by acting "upon the organs from which the nervous energy for the movements of vomiting is derived, or upon the organs of motion themselves?" Müller[1] thinks that this is still a matter of doubt.

---

[1] According to Müller (*Physiology*, by Baly, vol. i. p. 509), it is certainly probable that both the pneumogastric and splanchnic nerves act simultaneously in transmitting the irritation when emetic agents act on the stomach and intestines.

[2] Dr. M. Hall, *On the Diseases and Derangements of the Nervous System*, p. 104, Lond. 1841.

Emetics are employed for several purposes, of which the following are the most important:[2]—

1. To evacuate the stomach. They are resorted to for the purpose of expelling poisons (see *ante*, p. 163), undigested foods (crudities), or other foul matters (saburræ).

When the object is merely to empty the stomach of its contents, those emetics should be selected which occasion the least nausea and distress. For women and children, ipecacuanha is the mildest and safest emetic. For cases of poisoning, the sulphates of zinc and copper are preferred to emetic tartar: they operate speedily and effectually, but with less nausea than the last-mentioned salt. Other means of exciting vomiting in cases of poisoning have been already pointed out (see *ante*, p. 163).

2. To expel foreign bodies lodged in the throat or œsophagus. In cases of choking from the impaction of meat in the throat, the foreign body has been dislodged by provoking vomiting by means of a solution of emetic tartar injected into the veins (see *ante*, p. 136).

3. To excite nausea, and thereby to depress the vascular and muscular systems. For the fulfilment of this object emetic tartar is usually employed in strong subjects; but in females and children ipecacuanha is frequently substituted. Nauseants are used to reduce vascular action in some active hemorrhages, in inflammatory fever, and in acute inflammation of the lungs, testicles, mammæ, air-tubes, cellular membrane, skin, and joints: but in inflammation of the alimentary canal they are unsafe. They are employed to depress the tone of the muscular system in dislocations of the larger joints, and thereby to assist reduction by overcoming the force of the opposing muscles. In various spasmodic affections, as spasmodic asthma, hooping-cough, &c., the efficacy of nauseating emetics is referable to their depressing influence over the muscular fibre.

Emetics have been recommended to promote the passage of gall-stones, which they are said to do partly by relaxing the muscular fibres of the gall-ducts, partly by the concussion which they effect. But in acute cases they are usually unnecessary, as violent vomiting and great depression generally attend the passage of a biliary calculus.

4. To promote secretion and excretion. In hepatic derangements, especially those dependent on a torpid condition of the portal vessels, and in some cases of dyspepsia, emetics prove highly serviceable;—probably by promoting the secretion and excretion of bile, pancreatic juice, and gastric mucus. In inflammatory affections of the bronchial tubes, of the larynx and throat, emetics are often found useful: and they are so, probably, in part at least, by their augmenting secretion from the affected parts, and thereby promoting the resolution of the disease. The operation of an emetic is frequently succeeded by a soft, lax, and damp state of skin,—a condition highly favourable to the subsidence of very slight febrile disorders.

Order 4. Cathartica (καθαρτικά; from καθαίρω, *I purge* or *cleanse*);

---

[1] *Physiology*, by Baly, vol i. p. 510.

[2] For an account of the uses of emetics, consult Dr. Fothergill's Inaugural Dissertation, "*De Emeticorum Usu in variis Morbis tractandis*," Edinb. 1736. An English translation of this is published in his *Medical Works*, by J. C. Lettsom, M.D., Lond. 1784.

purgativa seu *purgantia* (from *purgo*, I purge or cleanse).—Medicines which produce alvine evacuations are called *cathartics* or *purgatives*.

The following is a list of officinal cathartics:—

1. VEGETABLE.

- RANUNCULACEÆ.
  - Helleborus niger—*Radix.*
  - " fœtidus—*Radix.*
- CRUCIFERÆ.
  - Sinapis alba—*Semina integra.*
- VIOLACEÆ.
  - Viola odorata—*Flores.*
- LINACEÆ.
  - Linum catharticum—*Herba.*
- GUTTIFERÆ.
  - Garcinia—*Gummi-resina Gambogia.*
- VITACEÆ.
  - Vitis vinifera—*Baccæ.*
- RHAMNACEÆ.
  - Rhamnus catharticus—*Baccæ.*
- LEGUMINOSÆ.
  - Cassia Fistula—*Leguminis pulpa.*
  - Tamarindus indica—*Legumen.*
  - Cassia; plurimæ species—*Folia Sennæ.*
  - Andira inermis—*Cortex.*
  - Copaifera; plurimæ species—*Oleo-resina.*
- ROSACEÆ.
  - Rosa centifolia—*Petala.*
  - " canina—*Fructus.*
  - Prunus domestica—*Fructus siccatus.*
- CUCURBITACEÆ.
  - Cucumis Colocynthis—*Fructûs pulpa.*
  - Momordica Elaterium—*Elaterium.*
- COMPOSITÆ.
  - Taraxacum Dens-Leonis—*Radix.*
- OLEACEÆ.
  - Olea europæa—*Fructûs oleum.*
  - Ornus europæa—*Succus concretus* (*Manna*).
- CONVOLVULACEÆ.
  - Convolvulus Scammonia—*Resina.*
  - Exogonium Purga—*Radix.*
- SOLANACEÆ.
  - Nicotiana Tabacum—*Folia.*
- POLYGONACEÆ.
  - Rheum; plurimæ species—*Radix.*
- EUPHORBIACEÆ.
  - Croton Tiglium—*Oleum.*
  - Ricinus communis—*Oleum.*
  - Euphorbia—(?)—*Resina* (*Euphorbium*).
- URTICACEÆ.
  - Ficus Carica—*Fructus.*
- CONIFERÆ.
  - Pinus; plurimæ species—*Oleum Terebinthinæ.*
  - Juniperus Sabina—*Folia.*
- LILIACEÆ.
  - Aloë; plurimæ species—*Succus concretus.*
- MELANTHACEÆ.
  - Colchicum autumnale—*Cormus.*
  - Veratrum album—*Cormus.*
- GRAMINEÆ.
  - Hordeum distichon—*Semina.*
  - Saccharum officinarum—*Saccharum impurum.*

2. ANIMAL.

Mel.

3. INORGANIC.

Sulphur.
Magnesia.
Magnesiæ carbonas.
" sulphas.
Potassæ sulphas.
Potassæ tartras.
" bitartras.
Sodii chloridum.
Sodæ sulphas.
" phosphas.
Sodæ potassio-tartras.
Hydrargyri chloridum.
Pilula hydrargyri.
Antimonii potassio-tartras.
Pulvis antimonii compositus.

Cathartics cause alvine evacuations by increasing the peristaltic motion of the intestines and by promoting secretions from the mucous lining. The milder purgatives, however, operate principally by their influence on the muscular coat of the intestines; while the stronger ones stimulate the mucous follicles and exhalants, and give rise to liquid evacuations. The former are sometimes termed *eccoprotics* (*eccoprotica; from* ἐκκόπρωσις, *a cleansing from dung, a purging*); while the latter are denominated *hydragogues* (*hydragoga;* ὑδραγωγά, from ὕδωρ, *water*, and ἀγωγός, *eliciting* or *evoking*). Some of them create nausea, faintness, occasionally vomiting, colicky pains, abdominal tenderness, and tenesmus. The more violent ones, if given in an over-dose, produce inflammation of the alimentary canal,[1] characterised by violent vomiting and purging, abdominal pain and tenderness, cold extremities, and sinking pulse. They are denominated *drastics* (*drastica*; *δραστικά*, from *δράω*, *I am active*). Emollient or demulcent drinks (as barley water, gruel, and broth) are taken to favour their safe operation.

---

[1] The deaths from the use of Morison's Pills are referable to this. The active ingredient of these medicines is gamboge (see *Lond. Med. Gaz.* vol. xiv. pp. 612 and 759; vol. xvii. pp. 357, 415, and 623; vol. xviii. pp. 75 and 927; vol. xix. p. 976).

As the intestinal surface consists of about 1400 square inches,[1] from the whole of which secretion and exhalation are going on, it is obvious that purging offers a very powerful means of diminishing the quantity of the fluids of the body; and accordingly we find that some cathartics, especially elaterium, cause very copious watery discharges; and their employment is followed, as might be expected, with thirst and augmented absorption from the serous cavities, so that they sometimes reduce or even remove dropsical swellings. The more violent purgatives promote the discharge of bile and pancreatic liquor, by the irritation they produce at the termination of the ducts which pour these secretions into the alimentary canal.

A distinction is usually made in practice between *cooling* and *warm* purgatives. By the former are commonly meant saline purgatives which, while they cause purging, without having any tendency to excite inflammation, are supposed to have a refrigerant influence over the system, and are adapted for febrile and inflammatory cases. By the latter are meant the more violent cathartics, which are presumed either to quicken the pulse, or at least to excite the abdominal vascular system, and, therefore, are considered to be less fitted for febrile cases.[2]

The more powerful cathartics are acrids or local irritants. Some of them (*e. g.* gamboge) operate almost solely in this way; for they do not excite purging except when they are introduced into the alimentary canal, and they easily excite vomiting when swallowed. But most of the drastics exert, in addition, a specific influence over the alimentary canal, so that they excite purging when injected into the veins, or when applied either to the serous membranes or cellular tissue. Senna, castor and croton oils, black hellebore, colocynth, and elaterium, operate in this way. This circumstance, therefore, favours the notion that they act, in part at least, after absorption.

A considerable number of cathartic substances have been detected in the blood and secretions (see *ante*, pp. 104 and 105).

The physical (endosmotic) action of purgative solutions has been already alluded to (see *ante*, pp. 95 and 96).

Some cathartics act also as diuretics, as bitartrate of potash and gamboge. Dr. Christison[3] observed, that where diuretics have been given for some time without effect, he has frequently seen their action brought on "by a single dose of some hydragogue cathartic, such as gamboge." The resinous particles, in their passage out of the system though the renal vessels, probably acted as topical stimulants.

Cathartics probably act, in part at least, by a reflex action of the ganglionic system. Müller[4] observes, that galvanising the splanchnic nerve or the cœliac ganglion, gives rise to a generally increased activity of the peristaltic movements, while division neither of the pneumogastric nor of the sympathetic nerve puts a stop to them. This appears to show that the splanchnic nerve is concerned in propagating the irritation set up by cathartics. The tenesmus occasioned by some cathartics is a reflex action of the true spinal system.

---

[1] This measurement has been calculated from the statements as to the length and diameter of the intestines in Meckel's *Manuel d'Anatomie générale, descriptive et pathologique*. Traduit par J. A. L. Jourdan et G. Breschet. Paris, 1825.

An anonymous writer, in the *London Medical Gazette*, vol. iv. p. 139, contends that aloes is not a warm purgative, though usually considered to be so.

[3] *On Granular Degeneration of the Kidneys*, p. 150, Edinburgh, 1839.

[4] *Physiology*, by Baly, vol. i. p. 511.

Different parts of the alimentary canal are unequally affected by different cathartics. Thus aloes is remarkable for its action on the large intestine; moreover, many of the drastic cathartics—as gamboge, colocynth, savin, and black hellebore—create more irritation in the large than in the small intestines; and Orfila[1] mentions that, in animals killed by these substances, he found the stomach and rectum inflamed, while the small intestines were healthy. In some cases, perhaps, this may be ascribed to the rapidity with which these agents pass through the small intestines, and on their longer continuance in the stomach and rectum; but the same appearance has been noticed when these cathartics have been applied to the cellular texture of the thigh.

Cathartics may be conveniently arranged in five groups, as follows:—

1. *Laxatives* or *lenitives* (*laxativa* vel *laxantia; lenitiva*).—This group contains the *mild cathartics* (*purgantia mitiora*), such as manna, cassia pulp, tamarinds, prunes, honey, bitartrate of potash, and the fixed oils (as castor, almond, and olive oils). These very gently evacuate the contents of the intestinal canal, and usually without causing any obvious irritation, or affecting the general system. Manna, however, is apt to occasion flatulence and griping. Laxatives are employed in any cases where we wish to evacuate the bowels with the least possible irritation,—as in children and pregnant women; in persons afflicted with inflammation of any of the abdominal or pelvic viscera, with hernia, prolapsus of the womb or rectum, piles, or stricture of the rectum; and after surgical operations about the abdomen and pelvis.

2. *Saline, antiphlogistic*, or *cooling cathartics* (*purgantia salina, antiphlogistica*).—This order is composed of the *saline* purgatives, such as the sulphates of soda, potash, and magnesia, &c. They increase the peristaltic motion of the alimentary canal, and augment the effusion of fluids by the exhalants of the mucous surface, thereby giving rise to watery stools.

If administered in the form of very dilute aqueous solutions they no longer act as cathartics, but become absorbed and act as diuretics (see *ante*, pp. 95 and 184). To operate as purgatives the solutions should be richer in saline matter than the blood is.[2]

[It must be remembered, however, that the purgative action of many of these salts, though it has been considered to be assisted by increasing the specific gravity of their solution, is probably not dependent on the endosmotic action induced, inasmuch as Dr. Carpenter[3] states that purgation may be produced by injecting the sulphate of magnesia into the stomach after placing a ligature below the pylorus. This must be by absorption.—ED.]

3. *Milder acrid cathartics* (*purgantia intermedia*).—This order includes senna, rhubarb, and aloes. These are more active substances than

---

[1] *Toxicologie Générale.*

[2] According to Liebig (*Researches on the Motion of the Juices in the Animal Body*, p. 60, Lond. 1848,) the blood contains from $\frac{3}{4}$ to 1 per cent. of common salt; consequently, saline solutions, to act as purgative, should contain more than one per cent. of saline matter. As this physical action of salts is common to all, and is independent of the nature of the acids and bases composing them, it is obvious that it does not explain why one salt is more purgative than another.

[3] *Carpenter's Human Physiology*, 4th edit.

any of the preceding. They are acrids and stimulants, but their local action is not sufficiently violent to cause inflammation. Senna is employed where we want an active, though not very acrid or irritant, purgative. Rhubarb is administered in relaxed and debilitated conditions of the alimentary canal, on account of its tonic properties. Aloes is used in torpid conditions of the large intestines, and in affections of the head. It is usually considered objectionable in piles and diseases of the rectum.

4. *Drastic cathartics* (*drastica ; purgantia fortiora*).—This group comprehends the *strong acrid purgatives ;* such as jalap, scammony, black hellebore, gamboge, croton oil, colocynth, and elaterium. These, when swallowed in large doses, act as acrid poisons. They are employed as purgatives in torpid conditions of the bowels ; as hydragogues in dropsical affections ; and as counter-irritants in affections of the brain. They are objectionable remedies in inflammatory and irritable conditions of the alimentary canal.

5. *Mercurial cathartics* (*purgantia mercurialia*).—The principal of these are the hydrargyrum cum cretâ, the pilula hydrargyri, and calomel. We employ them as alterative purgatives, and to promote the hepatic functions. As they are uncertain in their operation they are usually combined with, or followed by, other purgatives.

The following are the principal general uses[1] of cathartics :—

1. To evacuate the contents of the alimentary canal, and thereby to relieve those morbid symptoms which arise from their presence. The substances which cathartics are employed to remove are retained feculent matters, undigested foods, morbid secretions, worms, and poisonous agents (see *ante*, p. 164).

2. To promote secretion and exhalation from the gastro-intestinal mucous surface. Cathartics are employed directly for the production of this effect, and indirectly for the attainment of other objects, of which the following are the chief :—

α. The establishment of healthy alvine secretion when this is defective or perverted, especially in torpid conditions of the alimentary canal.

β. The promotion of the elimination of morbid agents contained in the blood,—either absorbed poisons (see *ante*, p. 164), or retained principles which ought to have been evacuated by other excreting organs.

γ. The diminution of the volume of the circulating fluid, and the relief of plethora, congestion, and other maladies dependent thereon.

δ. The augmentation of the action of the absorbents. Hydragogues which carry a large quantity of fluid out of the system by the bowels promote absorption, and thereby oftentimes prove most beneficial in dropsies.

ε. The antagonism of other secretions. Thus cathartics are employed to check excessive ptyalism from mercury, and to diminish the secretion of milk in nurses who are weaning.

ζ. The establishment of a substitute for other secretions. Thus, in defective secretion from the uterus, kidneys, &c., cathartics are employed to relieve the morbid symptoms resulting therefrom.

η. The relief of inflammation. Cathartics are frequently employed as antiphlogistics. They assist in removing or counteracting some of the elements of inflammation; and they do this in part by promoting secretion and exhalation from the gastro-intestinal canal; by which they relieve congestion of, and determination to, inflamed parts, lessen inflammatory fever, and promote the expulsion of morbid agents from the system and the absorption of some of the effused products of inflammation.

---

[1] On this subject, consult *Observations on the Utility and Administration of Purgative Medicines in several Diseases*, by J. Hamilton, M.D. Edinb. 1806. 3d edit. 1809.

3. To promote the secretion of the liver and pancreas. By irritating the orifice of the ductus communis choledochus, active cathartics produce an augmented secretion and excretion of bile and pancreatic juice; and hence these agents are well fitted for relieving those symptoms which arise from congestion or torpor of the portal system.

4. To stimulate or excite the muscular fibres of the alimentary canal, and thereby to relieve torpor, inactivity, or even a paralysed state of this organ. The torpor referred to exists chiefly in the cæcum and colon, and is most frequently met with in females. Although it is greatly relieved by the use of cathartics, these in general give only temporary relief: indeed, it not unfrequently happens that, after their action is over, the inactivity of bowel is augmented. Tonics, especially iron, and, in some cases, minute doses of the extract of nux vomica, aided by the occasional employment of cathartics, sometimes prove most effective. Aloetic purges are particularly useful when the condition of the uterus and rectum does not prohibit their use.

5. To affect remote organs on the principle of revulsion or counter-irritation (see *ante*, p. 128). Cathartics operate as revulsives or counter-irritants by the powerful impression which they make on the intestinal nerves, by the determination of blood they produce to the abdominal organs, and by the augmentation of secretion (intestinal, hepatic, and pancreatic) which they effect. They often prove most effective remedial agents in affections of the brain and other remote organs. In chorea, hysteria, determination of blood to the brain, or threatened apoplexy, and various other maladies, cathartics are most valuable remedies, operating apparently on the principle of counter-irritation.

6. To promote the catamenia. Some of the more active purgatives, particularly those which act in an especial manner on the large intestine, extend their irritating or stimulating influence to the whole of the pelvic vessels, and in this way frequently prove emmenagogue.

ORDER 5. DIAPHORETICA (διαφορητικά; from διαφορέω, *I throw off by perspiration*); *sudorifica* vel *sudorifera* (from *sudor*, sweat, and *facio*, I make, or *fero*, I produce); *hidrotica* (ἱδρωτικά; from ἱδρόω, *I perspire*); *diapnoica* (διαπνοϊκά (?); from διαπνοή, *evaporation* or *exhalation*).—Medicinal agents which promote the cutaneous transpiration are called *diaphoretics* or *sudorifics*.

The terms *diaphoretics* and *diapnoïcs* have been used to designate substances which augment the insensible perspiration; while the words *sudorifics* and *hydrotics* indicate substances increasing the sweat or sensible perspiration. But insensible perspiration and sweat differ in their physical conditions only; the former being the vaporous, the latter the liquid state of the same fluid. Hence there can be no essential difference between diaphoretics and sudorifics, and I, therefore, use the terms synonymously.

The agents which, under certain circumstances, augment cutaneous exhalation, are both numerous and heterogeneous. External heat, assisted by the copious use of diluents, constitutes an important and powerful means of promoting sweating. Whenever a large quantity of fluid is taken into the system, the excess is got rid of by the kidneys, the skin, and the lungs; and if we keep the skin warm, as by warm clothing, or the use of hot air or hot vapour-bath (see *ante*, pp. 13, 15, and 17), the action of the cutaneous exhalants is promoted, and sweating results; but if the skin be kept cool, the kidneys are stimulated, and the greater part of the liquid passes off through them. Friction, exercise, and all agents which excite vascular action, have a tendency to promote sweating. The sudden and temporary application of cold, as in the affusion of cold water (see *ante*, p. 30), sometimes proves sudorific by the reaction which it occasions. Lastly, many medicinal agents, acting through the circulation, cause sweating. These are the sudorifics or diaphoretics properly so called.

The following is a list of the officinal diaphoretics :—

1. ORGANIC.

- Papaveraceæ.
  - Papaver somniferum—*Opium.*
- Cruciferæ.
  - Sinapis nigra—*Semina.*
- Polygalaceæ.
  - Polygala Senega—*Radix.*
- Ternstromiaceæ.
  - Thea viridis—*Folia.*
  - " Bohea—*Folia.*
- Zygophyllaceæ.
  - Guaiacum officinale—*Resina.*
- Leguminosæ.
  - Copaifera; plurimæ species—*Oleo-resina.*
- Cinchonaceæ.
  - Cephaëlis Ipecacuanha—*Radix.*
- Asclepiadaceæ.
  - Hemidesmus indicus—*Radix.*
- Solanaceæ.
  - Solanum Dulcamara—*Stipites.*
  - Capsicum annuum—*Fructus.*
- Labiatæ.
  - Hyssopus officinalis—*Herba.*
  - Melissa officinalis—*Herba.*
  - Mentha Pulegium—*Herba.*
  - Rosmarinus officinalis—*Herba.*
  - Salvia officinalis—*Herba.*
- Thymelaceæ.
  - Daphne Mezereum—*Cortex radicis.*
- Lauraceæ.
  - Camphora officinarum—*Camphora.*
  - Sassafras officinale—*Lignum.*
  - Laurus nobilis—*Folia.*
- Aristolochiaceæ.
  - Aristolochia Serpentaria—*Radix.*
- Urticaceæ.
  - Dorstenia Contrajerva—*Radix.*
- Ulmaceæ.
  - Ulmus campestris—*Cortex.*
- Smilaceæ.
  - Smilax; plurimæ species—*Radix Sarsæ.*

- Alcohol.
- Vinum.
- Ætherea.
- Olea volatilia.
- " empyreumatica.

2. INORGANIC.

- Ammoniæ sales.
- Salia neutra (see *ante*, p. 182).
- Antimonialia } (see *ante*, p. 188).
- Mercurialia }

Diaphoretics are relative agents; they succeed only in certain states of the body. Moreover, for different conditions different diaphoretics are required. They constitute an exceedingly uncertain class of remedies, with regard both to the production of sweating and to the advantage to be derived therefrom. Dr. Holland[1] suggests that when benefit follows the use of diaphoretic medicines, it is often ascribable, not to their direct influence on the exhalant vessels, but to other changes which they excite in the system, of which sweating is to be regarded rather as the effect and proof than as the active cause.

The operation of diaphoretics is promoted by the exhibition of large quantities of warm mild diluents, and by keeping the skin warm. Moreover, they are more effective when given at bed-time, since there appears to be greater disposition to sweating during sleep than in the waking state. The exhibition of diuretics should be avoided during the operation of diaphoretics, as they appear to check the operation of the latter. The same rule has been laid down with regard to purgatives; but it is well known that perspiration is often the consequence of hypercatharsis.

---

[1] *Medical Notes and Reflections*, p. 52, Lond. 1839.

Dr. Edwards[1] has shown that cutaneous transpiration is effected in two ways,—by a physical action or evaporation, and by an organic action or transudation. *Evaporation*, or the physical action, is the consequence of the porosity of bodies, and takes place equally in the dead and living state. It is influenced by the hygrometric states of the surrounding air, by its motion or stillness, by its pressure, and by its temperature. Thus dryness, agitation, and diminution of the weight of the air, increase it. *Transudation*, or the organic action of transpiration, is a vital process, effected by minute spiral follicles or sudoriferous canals, and depends essentially on causes inherent in the animal economy, although it may be influenced to a certain extent by external agents. Thus, elevating the temperature of the surrounding air, preventing its frequent renewal, and covering the patient with warm clothing, are means which promote the organic, but check the physical, action of transpiration. Diaphoretics affect the transudation or the vital process. They probably affect the exhalants in one or both of two ways; by increasing the force of the general circulation, or by specifically stimulating the cutaneous vessels.

Diaphoretics may be arranged in seven groups, as follows:—

1. *Aqueous diaphoretics.*—Under this head are included not only simple water, but gruel, whey, and tea. These, when assisted by external warmth, often prove very effective diaphoretics, even when used alone; while to all the other groups they are valuable adjuvants; and in no cases are they injurious.

2. *Alkaline and saline diaphoretics.*—The salts of the alkalies are frequently used to promote perspiration. Acetate and carbonate of ammonia, alkaline citrates and tartrates, sal ammoniac, and nitrate of potash, are employed for this purpose in fevers.

3. *Antimonial diaphoretics.*—The liquefacient operation of antimonials has been already referred to (see *ante*, pp. 179 and 189). Diaphoresis is one of its consequences. We use this group of diaphoretics in febrile and inflammatory cases. It is preferred to the opiate diaphoretics when there is inflammation or congestion of the brain, or a tendency to either of these conditions.

4. *Opiate diaphoretics.*—Opium and its alkali morphia have a remarkable tendency to produce sweating. The former is often used as a diaphoretic, commonly in the form of Dover's powder, when no disorder of the brain exists; and especially when an anodyne is indicated. When the stomach is very irritable, an opiate diaphoretic is preferred to an antimonial one. In rheumatism and slight catarrhs, Dover's powder proves highly serviceable. In diabetes and granular disease of the kidneys, it is the best sudorific we can use, especially when conjoined with the warm bath.[2] Opium and camphor form a serviceable sudorific compound when the surface is cold, as in cholera.

5. *Oleaginous and resinous diaphoretics.*—This group includes a large

---

[1] *De l'Influence des Agens Physiques sur la Vie*, Paris, 1824.

[2] See Dr. Osborne's paper, in *The Dublin Journal of Medical and Chemical Science*, Jan. 1834. Also Dr. Christison, *On Granular Degeneration of the Kidneys*, Edinb. 1839.

number of substances, some of which owe their activity to volatile oil, as the Labiatæ and the Lauraceæ (*e. g.* sassafras and camphor); others to resin, as mezereon and guaiacum; while some contain both oil and resin, as copaiva and the turpentines. The substances of this order possess stimulant properties. They probably act locally on the cutaneous vessels through the blood; for some of them (*e. g.* copaiva) can be detected by their odour in the perspiration, and they occasionally excite a slight eruption on the skin. The diaphoretics of this group are useful in chronic rheumatism, secondary syphilis, and chronic cutaneous diseases.

6. *Alcoholic diaphoretics.*—Alcohol and wine augment cutaneous exhalation.

7. *Ipecacuanha.*—I believe the diaphoretic property of ipecacuanha to be considerably less than is commonly supposed. Dover's powder owes its power of producing sweating almost exclusively to the opium which it contains.

Diaphoretics are employed for various purposes, of which the following are the chief:—

1. To restore the cutaneous secretion when it has been checked by cold, and thereby to relieve the ill consequences of its suppression. The milder forms of disease, induced by what is familiarly termed "catching cold," are oftentimes successfully treated by the use of diluents and diaphoretics. In catarrhal and rheumatic affections they are employed with great benefit.

2. To promote the subsidence of diseases which naturally terminate by augmented cutaneous secretion or exanthematous eruptions; as in simple continued fever, the exanthemata, and intermittents.

3. To produce determination to the surface in various maladies attended with coldness of the skin and congestion of internal organs.

4. To antagonise other secretions. Thus diaphoretics are employed to check excessive secretion of urine (see *ante*, p. 130), and sometimes to relieve diarrhœa. Opium is a valuable agent in some of these cases; for, while it acts as a diaphoretic, it checks secretion from the kidneys and intestines: and hence in diabetes and diarrhœa it serves a two-fold purpose.

5. To establish a substitute for some other secretion. Both the skin and kidneys are engaged in the common function of eliminating water; and hence when the renal secretion is diminished or suppressed we endeavour to relieve the system by the use of diaphoretics. In dropsy from granular degeneration of the kidney, the employment of warm-baths and Dover's powder is frequently attended with great benefit.

ORDER 6. SIALAGOGA (σιαλαγωγά (?); from σίαλον, *saliva*, and ἀγωγός, *eliciting* or *evoking*); *ptyalagoga* (πτυαλαγωγά (?); from πτύαλον, *saliva*, and ἀγωγός).—Medicines which augment the secretion of saliva and buccal mucus are denominated *sialagogues*.

Sialagogues are of two kinds: some produce their effect by direct application to the mouth; others are swallowed, and require to be absorbed before they act as such. The former are called *topical sialagogues*; the latter are the *remote* or *specific sialagogues*.

SUB-ORDER α. TOPICAL SIALAGOGUES.—These are sialagogues which are applied to the mouth. When used in a soft or solid state they are called *masticatories* (*masticatoria*; from *mastico*, I eat or chew). They act on the mucous follicles of the mouth and the salivary glands. Most solid or soft bodies, when chewed, increase the flow of saliva; but acrids do this in an eminent degree. The following is a list of officinal topical sialagogues:—

- CRUCIFERÆ.
  - Cochlearia Armoracia—*Radix*.
- SOLANACEÆ.
  - Nicotiana Tabacum—*Folium*.
- COMPOSITÆ.
  - Anacyclus Pyrethrum—*Radix*.
- THYMELACEÆ.
  - Daphne Mezereum—*Cortex radicis*.
- ZINGIBERACEÆ.
  - Zingiber officinale—*Rhizoma*.

In almost all parts of the world masticatories are more or less used. In the East Indies betel-nuts (the seeds of Areca Catechu) are chewed, with quicklime and the betel leaf (the leaf Piper Betel). The Indians have a notion that these substances fasten the teeth, clean the gums, and cool the mouth.[1] In this country the masticatory commonly employed by sailors is tobacco.

As the saliva is generally swallowed, masticatories do not confine their action to the mouth, but excite likewise the stomach. Peron[2] was convinced that he preserved his health, during a long and difficult voyage, by the habitual use of the betel; while his companions, who did not use it, died mostly of dysentery. For habitual use, and as mere sialagogues, mucilaginous and emollient masticatories might be resorted to, but we find that acrids of various kinds have always been preferred. Masticatories, as therapeutic agents, have been principally used either as topical applications in affections of the gums, tongue, tonsils, salivary glands, &c., or as counter-irritants in complaints of neighbouring organs, as in ear-ache, rheumatism of the pericranium, affections of the nose, &c. The stronger masticatories, as mustard and horse-radish, excite an increased discharge of nasal mucus and tears, as well as of saliva and mucus of the mouth.

SUB-ORDER β. SPECIFIC OR REMOTE SIALAGOGUES.—Several substances have had the reputation of producing salivation or ptyalism by internal use. Of these, the preparations of mercury (see *ante*, p. 188) are the only ones on which much reliance can be placed, and even they sometimes disappoint us. The preparations of gold, of antimony (see *ante*, p. 188), and of iodine (see *ante*, p. 186), occasionally have this effect. The continued use of the hydrocyanic or nitric acid has, in several instances, produced salivation. In poisoning by foxglove the same has been observed. Lastly, nauseants increase the secretion of saliva. Mercurials are given in certain diseases to excite ptyalism, and in some cases it is necessary to keep up this effect for several weeks. It is not, however, supposed that the salivation is the cause of the benefit derived, but an indication that the constitution is sufficiently influenced by the medicine.

ORDER 7. CHOLAGOGA (χολαγωγά; from χολή, *bile*, and ἀγωγός, *eliciting or evoking*).—Medicines which promote the secretion or excretion of bile are denominated *cholagogues*.

It is probable that most, if not all, drastic purgatives increase the secretion and excretion both of bile and pancreatic juice, by irritating the opening of the ductus choledochus in the duodenum; just as certain substances, taken into the mouth, provoke an increased discharge of saliva, by irritating the mouths of the salivary ducts. Graaf[1] says, that if a purgative be administered to a dog, and, when it is beginning to operate, the abdomen be laid open, the bile and pancreatic juice will be observed flowing into the duodenum.

---

[1] Ainslie's *Materia Indica*.

[2] *Voyage aux Terres Australes*, Paris.

The agents before noticed under the name of liquefacients (see *ante*, p. 179) probably increase the secretion of bile in common with the other secretions.

The term cholagogue, however, has been more particularly applied to substances which have been supposed to have a specific influence in promoting the secretion or excretion of bile. Mercury, aloes, rhubarb, and taraxacum, have been considered to possess this property.

Cholagogues are employed to promote the secretion and excretion of bile in maladies in which these functions are defective, and generally in torpid conditions of the portal system.

ORDER 8. DIURETICA (διούρητικά; from διά, *through*, and οὐρητικά); *uretica* (οὐρητικά; from οὐρέω, *I make water*); *urinalia*.—Medicinal agents which promote the secretion of urine are called *diuretics*.

The following is a list of the officinal diuretics :—

1. VEGETABLE.

- MENISPERMACEÆ.
  - Cissampelos Pareira—*Radix*.
- CRUCIFERÆ.
  - Cochlearia Armoracia—*Radix*.
  - " officinalis—*Herba*.
  - Sinapis nigra—*Semina*.
  - " alba—*Semina*.
- POLYGALACEÆ.
  - Polygala Senega—*Radix*.
- GUTTIFERÆ.
  - Garciniæ species incerta—(?)—*Gummi-resina Gambogiæ*.
- RUTACEÆ.
  - Barosma; plurimæ species—*Folium* (*Buchu*).
- LEGUMINOSÆ.
  - Copaifera; plurimæ species—*Oleo-resina*.
  - Cytisus scoparius—*Cacumen*.
- MYRTACEÆ.
  - Melaleuca minor—*Oleum Cajuputi*.
- UMBELLIFERÆ.
  - Petroselinum sativum—*Radix*.
  - Daucus Carota—*Fructus*.
- COMPOSITÆ.
  - Taraxacum Dens-Leonis—*Radix*.
- PYROLACEÆ.
  - Chimaphila umbellata—*Folia*.
- ERICACEÆ.
  - Arctostaphylos Uva-ursi—*Folia*.
- SOLANACEÆ.
  - Nicotiana Tabacum—*Folia*.
- SCROPHULARIACEÆ.
  - Digitalis purpurea—*Folia*.
- PIPERACEÆ.
  - Piper Cubeba—*Fructus*.
- CONIFERÆ.
  - Pinus; plurimæ species—*Oleum terebinthinæ*.
  - Juniperus communis—*Oleum volatile*.
- MELANTHACEÆ.
  - Colchicum autumnale—*Cormus*.
- LILIACEÆ.
  - Urginea scilla—*Bulbus*.
  - Asparagus officinalis—*Radix*.

Alcohol. | Vinum (Rhenanum). | Spiritus ætheris nitrici.

2. ANIMAL.

Cantharis vesicatoria.

3. INORGANIC.

Alkalina (see *ante*, p. 180).
Salia neutra et media (see *ante*, p. 182).
Sapo.
Iodica et bromica (see *ante*, p. 186).
Acida mineralia diluta (see *ante*, p. 174).
Mercurialia et antimonialia (see *ante*, p. 188).
Aqua.

There are two principal modes of promoting the secretion of urine: the one direct, the other indirect. The *indirect* method consists in augmenting the quantity of fluids taken into the stomach, or in removing any cause which checks the secretion. The *direct* mode is to stimulate the kidneys by means which specifically affect these organs. These means are the diuretics properly so called.

---

[1] Barbier, *Traité Élément. de Mat. Méd.* t. iii. p. 1252, 2nde éd.

The quantity of urine secreted in the healthy state is liable to considerable variation. Temperature, season of the year, climate, time of day, quantity of fluid consumed as drink, state of health, &c., are among the common circumstances modifying this secretion. Whenever an unusual quantity of aqueous fluid is taken into the system, the kidneys are the organs by means of which the excess is, for the most part, got rid of. If the customary discharge from the skin or lungs be checked—by cold, for instance—the kidneys endeavour to make up for the deficiency of action in the other organs. Thus in winter and in cold climates, more urine is secreted than in summer and in hot climates. Again, if transpiration be promoted, as by external warmth, the secretion of urine is diminished. Hence, when we wish to augment the renal secretion, diluents should be freely administered, and the skin kept cool.

Mr. William Alexander[1] endeavoured to determine, as nearly as possible, the relative powers of different diuretics; and he has given the following tabular views of his results:—

A TABLE *of the different quantities of urine always discharged in an equal time; viz. from nine o'clock in the morning till two o'clock in the afternoon, when an equal quantity of the same liquid was drunk, but with different diuretics, in different quantities, dissolved in it.*

	℥	ʒ	℈
By ℔j. ʒvijss. of simple infusion of bohea tea, standard	15	4	0
Ditto, with ʒij. of salt of tartar	22	7	2
" ʒij. of nitre	22	0	0
" 4 drops of oil of juniper	30	3	0
" ʒj. of salt of wormwood	19	7	1½
" ʒij. of Castile soap	19	1	1
" a teaspoonful of spt. nitr. dulc.	17	6	1½
" 15 drops of tinc. cantharides	16	4	0
" ʒij. of sal polychrest	16	3	0
" ʒss. of uva ursi	16	1	0½
" ʒj. of magnesia alba	15	5	0
" ʒij. of cream of tartar	10	2	0½

A TABLE *of the different quantities of urine evacuated in the same space of time, after drinking the same quantity of different liquors.*

	℥	ʒ	℈
By ℔j. ℥viijss. of weak punch, with acid	21	2	3
" new cow whey	18	6	0
" decoct. diuret. Pharm. Edin.	17	5	0
" London porter	16	7	0
" decoct. bardan. Pharm. Edin.	14	7	0
" warm water gruel	14	6	2
" small beer	13	7	1
" warm new milk	11	7	0

These tables are to a certain extent useful; but as diuretics act very unequally at different times, and cannot, therefore, be relied on, the value of Mr. Alexander's experiments is considerably diminished.

By augmenting the secretion of urine we diminish the quantity of blood in the blood-vessels; and thus create thirst and promote absorption from the serous cavities.

There is reason to believe that all diuretic medicines, strictly so termed, become absorbed, are carried in the blood to the kidneys, and are there eliminated, either unchanged or more or less altered. I have already (see *ante*, p. 105) enumerated the medicinal agents which have been detected in the urine. To the list before given may be added the following, which, according to Dr. Vetter,[1] pass off by urine:—

---

[1] *Experimental Essays*, Edinb. 1768.

Asparagin.
Almost all astringents.
Acrid matter of cubebs.
Balsam of copaiva.
Veratria.

We must not, however, imagine that every substance which can be detected in the urine is a diuretic, for in some instances this is evidently not the case; and, on the other hand, there are several medicines whose active principles are supposed to excite an increased flow of urine by absorption and local contact with the renal vessels, but which cannot be recognised in this secretion on account of the absence of any known sensible or chemical characters by which these principles can be readily detected.

It is probable that all agents which prove diuretic by their direct stimulant influence over the kidneys, do so by their topical action on these organs (see p. 114). It follows, therefore, that in order to enable them to reach the kidneys they must be administered either in solution or in such a condition that they may become dissolved in the fluids of the gastro-intestinal canal. Moreover, the solutions should be very dilute; otherwise, instead of becoming absorbed, they act as cathartics (see *ante*, p. 95). I have before referred to Laveran and Millon's experiments with tartarized soda (see *ante*, p. 184). When solutions of this salt caused purgation, they did not become absorbed: on the contrary, solutions which did not purge became absorbed and rendered the urine alkaline.[2]

Mr. Bowman[3] considers that "the parts concerned in the secretion of that portion of the urine to which its characteristic properties are due (the urea, lithic acid, &c.)" are the uriniferous tubes and their plexus of capillaries; and that the Malpighian bodies are "an apparatus destined to separate from the blood the watery portion." Diuretic medicines, he says, "appear to act specially on the Malpighian bodies; and various foreign substances, particularly salts, which, when introduced into the blood, pass off by the urine with great freedom, exude, in all probability, through this bare system of capillaries. The structure of the Malpighian tubes indicates this; and also, as far as they are known, the laws regulating the transmission of fluids through organized tissues, modified in their affinities by vitality."

The uncertainty of the action of diuretic medicines in the cases in which their influence is specially desired—namely, in dropsies, is well known to every practitioner. Now, in a very large majority of cases, dropsy arises from organic disease of the heart, kidneys, liver, or lungs; and to the influence of these maladies must be referred the failure of the so-called diuretics to augment the secretion of urine. "If," says Dr. Barlow,[4] "a sufficient quantity of water cannot be received into the small intestines, or the circuit through the portal system in the vena cava ascendens, or thence through the lungs and heart into the systemic circulation, be obstructed; or if there be extensive disorganization of the kidneys, the due secretion of urine cannot be effected."

---

[1] *Pharmaceutisches Central-Blatt für* 1837, p. 811.

[2] [This statement must be received with modification: vide page 184.—ED.]

[3] *Phil. Trans.* for 1842.

[4] *Guy's Hospital Reports*, Oct. 1844, p. 367.

When the obstruction exists in the portal system, medicines calculated to relieve this should be conjoined with the diuretics, whose operation they greatly promote. Hence the efficacy in these cases of administering mercurials (as blue pill or calomel) with diuretics. So also active cathartics sometimes augment the secretion of urine and aid the operation of diuretics by irritating the mouth of the ductus communis choledochus, causing an increased discharge of bile and pancreatic juice, and thereby relieving a congested state of the liver.

When the obstruction exists in the chest (heart or lungs), the operation of diuretics is aided by agents, such as digitalis, which tranquillise the action of the heart.

Considered with reference to their chemical properties, or to the nature and effects of their active principles, the diuretics may be arranged in the following groups:—

1. *Aqueous diuretics.*—Aqueous drinks promote diuresis indirectly, when the skin is kept cool, as I have before mentioned.

2. *Alkaline and saline diuretics.*—This group includes the alkalies and the alkaline and earthy salts.

The alkaline salts which contain a vegetable acid appear in the urine in the form of alkaline carbonates (see *ante*, pp. 183 and 184).

I have already stated that when saline substances are employed as diuretics they should be given in the form of dilute aqueous solution, as strong solutions act as cathartics. Liebig[1] states that the saline contents should be less than those of the blood, which contains from ¾ to 1 per cent. of chloride of sodium.

3. *Iodic and bromic diuretics.*—The iodic and bromic compounds are seldom used as diuretics.

4. *Mercurial and antimonial diuretics.*—Mercurials (especially blue pill, calomel, and bichloride of mercury) are frequently given in conjunction with the diuretics properly so called. They are useful by their influence over the portal circulation and as sorbefacients. Antimonials are seldom administered as diuretics.

5. *Acid diuretics.*—The dilute mineral acids sometimes act as diuretics (see *ante*, pp. 174—178). Dalton[2] found that vinegar diminished the secretion of urine.

6. *Sedative diuretics.*—This group includes tobacco and fox-glove, whose power of reducing the force and frequency of the heart's action has been already referred to (see *ante*, p. 233). The diuretic effect has been referred, by Dr. Paris,[3] to their sedative operation. For, as the energy of absorption is generally in the inverse ratio of that of circulation, it is presumed that all means which dimininish arterial action must indirectly prove diuretic by exciting the function of absorption. I have already explained how, in cardiac dropsy, foxglove may promote the diuretic effect of other substances (see *ante*, p. 258).

---

[1] *Researches on the Motion of the Juices in the Animal Body*, Lond. 1848.

[2] *Memoirs of the Literary and Philosophical Society of Manchester*, 2d series, vol. v. Lond. 1831.

[3] *Pharmacologia*, 9th edit. p. 220, 1843.

7. *Bitter acrid diuretics.*—To this group belong squills, colchicum, common broom, &c. These agents, in an over-dose, readily occasion vomiting. They owe their activity to an acrid principle, which operates, through the circulation, on the renal vessels as a local stimulant or irritant, and in this way proves diuretic. According to my own observations, common broom less frequently fails to prove diuretic than most other agents of this class.

8. *Acrid diuretics whose active principle is volatile oil.*—A considerable number of diuretics are referable to this group; as the cruciferous diuretics, buchu, copaiva, cajuputi, turpentine, juniper, and cantharides. The volatile oil is absorbed, and is carried by the blood to the kidneys, on which it acts topically as a stimulant.

9. *Alcoholic and ethereal diuretics.*—This group includes alcohol, wine, and nitric ether.

Diuretics are employed for various purposes, of which the following are the principal:—

1. To restore the healthy action of the kidneys in diseases generally in which the secretion of urine is diminished.

2. To promote the absorption of dropsical effusions. In most dropsies the renal secretion is diminished; and the obvious indication, therefore, is to augment this secretion in order not only to prevent further effusion, but also to promote the absorption of the fluid already effused. With this view diuretics are administered; but, as I have already observed, they frequently fail to augment the quantity of urine (see *ante*, p. 258). In the dropsy which follows scarlatina, the saline diuretics (especially nitrate of potash) with purgatives (jalap and bitartrate of potash) in general prove successful. In dropsy dependent on granular diseases of the kidney, diuretics (digitalis, colchicum, and cantharides) are, in the early period of the disease, of benefit. They should be preceded by, or alternated with, hydragogues (elaterium or jalap and bitartrate of potash), diaphoretics (Dover's powder), and warm-bathing. With the exception of warm-bathing, the same plan may be adopted for the relief of dropsy arising from cardiac disease.

3. To promote the elimination of poisonous agents from the system (see *ante*, p. 163).

4. To augment the elimination of water, and thereby to enable the urine to keep in solution the solid constituents of this secretion, as well as to act as a solvent for calculi contained in the urinary organs (see *Lithica*).

5. To relieve inflammatory action. Saline diuretics form part of the antiphlogistic treatment employed in inflammation.

2. *Diminishing secretion.*

(Sistentia; Reprimentia; Cohibentia; ἐπισχετικά.)

These are the remedies for fluxes. Considered with regard to the nature of their effect, they are of three kinds,—cerebro-spinals, astringents, and acrid stimulants.

a. Cerebro-spinalia.—Of the cerebro-spinal agents which check secretion, opium and its active principle morphia are the most powerful and constant in their effects. Opium checks all the secretions except that of the skin, which it promotes. Linnæus[1] excepts also the milk, menses, and lochiæ. Sprœgel[2] asserts that though opium checks the excretion of bile and urine, it does not diminish their secretion; for, in animals to whom he had administered opium, he found the ductus choledochus filled with bile, though the fæces, like those of jaundiced persons, were scarcely coloured; and the bladder filled with urine, although none had been passed for three days. But though opium checks the excretion of bile and urine, it undoubtedly also diminishes the secretion of these fluids.

Opium or morphia is employed to check profuse secretion in bronchial, gastric, intestinal, and renal fluxes; for example, catarrh, diarrhœa, diabetes, and hydruria. It is adapted for fluxes attended with an irritable condition of organs.

β. *Astringentia.*—The astringents employed for checking secretion include most of the topical astringents already mentioned (see *ante*, p. 162), the mineral acids (see *ante*, p. 174), and the astringent tonics (see *ante*, p. 214).

They act topically on the secreting organ—either directly, by application to the part, or indirectly, by absorption. They are most effectual when they are applied directly to the secreting organs (see *ante*, p. 162). They are much less so when applied to a distant part; for, though they become absorbed and are carried by the blood to the secreting organ, they undergo some chemical change in their passage by which their astringent influence is oftentimes considerably diminished.

The astringents check fluxes by their chemical influence over the tissues. They constringe the relaxed vessels. They are, therefore, adapted for asthenic fluxes attended with a weak or lax condition of the affected parts. They are employed in bronchial, gastric, intestinal, renal, urethral, and vaginal fluxes, and in profuse perspiration. In bronchorrhœa, the most frequently employed astringents are the sulphate of zinc and the acetate of lead; in pyrosis, the trisnitrate of bismuth; in diarrhœa and dysentery, the vegetable astringents (see *ante*, p. 214), acetate of lead, and sulphate of copper; in hydruria, sesquichloride of iron; in urethral and vaginal fluxes, the preparations of iron and zinc; in profuse perspiration, sulphuric acid; in cystorrhœa, uva ursi.

γ. *Stimulantia.*—The acrid stimulants used for checking secretion belong to the ethereal-oily and the resinous stimulants before noticed (see *ante*, pp. 223 and 228). Volatile oil and resin are their active constituents. These become absorbed, and are carried by the blood to the secreting organs, on which they exercise their influence.

The stimulants are employed to check secretion from the mucous surface, in asthenic fluxes originating from inflammation; though sometimes, instead of curing the disease, they augment irritation and inflammation. In what way they operate as remedies for fluxes is very uncertain. Dr. Williams[3] thinks that "it is probably in removing congestions by causing determination of blood, which excites contraction, and improved tone of the capillaries of the part." (See *Repellents, ante,* p. 163.)

---

[1] *Amœn. Acad.* viii. 298.

[2] Quoted by Dr. C. A. Christen (*Opium historice, chemice atque pharmacologice investigatum*, Vindobonæ, 1820).

[3] *Principles of Medicine*, 2d edition, p. 236, Lond. 1848.—Dr. Williams (p. 198) observes that "the influence of stimulants on congestion may be illustrated by the microscope. A solution of capsicum applied to a frog's web, congested after previous irritation, causes an enlargement of the arteries, an increased flow of blood, and, in some instances, causes the vessels to contract afterwards to their natural size, so that the congestion is completely removed: in that case the cure is complete. In other instances, however, the stimulants fail to clear the congested vessels: the enlarged arteries pour in more blood; but this, not overcoming the obstruction, increases the

The acrid stimulants are more likely to prove beneficial in repressing secretion when the irritation or congestion is slight; but when this is violent, or when inflammation is present, they are apt to aggravate the malady.

In diarrhœa, the aromatics (see *ante,* p. 227) are used to check secretion; in bronchorrhœa, balsams of copaiba and Peru; in gonorrhœa and leucorrhœa, cubebs, balsam of copaiba, the terebinthinates, and cantharides; in cystorrhœa, buchu.

3. *Altering the quality of the secretions.*

(Eccritica alterantia vel alloiotica.)

It is but seldom that our sole object, in affecting the secretions, is that of altering their quality: usually we also desire to augment or lessen them; and the agents which produce this likewise produce a change in the quality of the secretions.

We endeavour to alter the quality and improve the condition of the secretions in all diseases in which these present a morbid character; and we usually attempt this by agents which likewise augment the secretion.

But the altered condition of the secretions in some cases gives rise to certain inconveniences and secondary disorders, the prevention or relief of which is the special object of the agents which are administered to alter the quality of the secretions. It is frequently an indication to attenuate the secretions and to render them more fluid. Thus we endeavour to effect this in bronchial affections when the mucus is very viscid and clogs up the tubes; in acne punctata, in which the thick sebaceous matter accumulates in the follicles and gives rise to induration and suppurative inflammation; and when there is reason to suspect the existence of inspissated bile or a gall-stone.

In most of these cases we employ agents that increase, as well as alter the quality of, the secretions.

The only order of alterative eccritics which it will be necessary to notice separately is one including agents employed to modify the qualities of the urine for the relief of stone and gravel.

ORDER 9. LITHICA (λιθικά; from λίθος, *a stone* or *urinary calculus*). Medicines for the stone and gravel.—Under the name of *lithics* are included medicines which counteract the predisposition to the formation of urinary calculi, or which are employed with the view of effecting the solution or disintegration of urinary concretions within the body.

Medicines "which counteract the predisposition to the formation of calculous concretions in the urinary organs" are called by Dr. A. T. Thomson,[1] *antilithics* (*antilithica*).

Solvents for the stone are usually denominated *lithontriptica* or (more correctly)

---

hyperæmia, and, as we shall afterwards see, may convert it into inflammation. Thus it appears that stimulants as well as astringents, though occasionally proving remedies for congestion, sometimes tend to increase it."

[1] *Elements of Materia Medica and Therapeutics.*

lithonthryptica (from λίθος, *a stone* or *urinary calculus*, and θρυπτικός, from θρύπτω, I *break* or *crush*). Pliny[1] terms them *saxifraga* (from *saxum*, a stone, and *frango*, I break). They might with more propriety be termed *lithonlytica* (from λίθος and λύω, *I dissolve* or *break up*).

The constituents of urinary concretions, for the prevention or removal of which lithics are administered, are the following:—

Lithic or uric acid.
Lithate of ammonia.
Oxalate of lime.
Cystic oxide.
Xanthic oxide.
Carbonate of lime.
Phosphate of lime.
Phosphate of magnesia and ammonia.

The following is a list of medicinal agents used as lithics:—

VEGETABLE.

PAPAVERACEÆ.
Papaver somniferum—*Opium*.
ROSACEÆ.
Alchimilla arvensis—*Herba*.
UMBELLIFERÆ.
Daucus Carota—*Fructus*.
ERICACEÆ.
Arctostaphylos Uva Ursi—*Folium*.
URTICACEÆ.
Parietaria officinalis—*Herba*.
CONIFERÆ.
Pinus; plurimæ species—*Terebinthina*.

Astringentia vegetabilia } (see *ante*, pp. 214–15.)
Amara vegetabilia }
Acida vegetabilia (see *ante*, pp. 174–177).
Acidum benzoicum (see *ante*, p. 176.)
Acidum cinnamicum.
Acidum malicum.

INORGANIC.

Aqua.
Acida mineralia (see *ante*, pp. 174–177).
Acidum carbonicum.
Alkalina (see *ante*, pp. 180–182).
Sapo.
Lithiæ carbonas.
Borax.
Sodæ phosphas.
Salia neutra vegetabilia (see *ante*, pp. 182–186).
Plumbi nitro-saccharas.
Aquæ minerales (*Malvern*; *Vichy*).

Diuretica (see *ante*, p. 256).

In the treatment of lithiasis two objects require attention: one is the prevention of calculous depositions within the body; and the other is the removal of the already deposited matter. The second object is attempted by means, some of which are medical, others surgical: the latter will of course not require notice here.

The preventive treatment of lithiasis varies somewhat according to the chemical nature of the urinary deposit; but in a general way it may be said to consist in a strict attention to diet and regimen, the promotion of the cutaneous functions, the regulation of the condition of the stomach and bowels, and the employment of lithics or medicines which, by their special influence over the urinary organs and the urine, prevent the formation of urinary deposits.

Lithics, considered with reference to their influence over the urine, are of three kinds,—diuretics, alteratives, and solvents.

1. *Diuretic lithics.*—Medicinal agents which possess a diuretic quality have long been celebrated in the treatment of stone and gravel.

In some cases they appear to act by increasing the quantity of water secreted by the kidneys, and thus, by rendering the urine more dilute, enable this secretion to retain in solution its solid constituents. In other cases they appear to give relief by promoting the secretion of lithic acid,[1] which, in some cases, appears to act as a sort of *materies morbi* (Prout). In this way Dr. Prout[2] thinks that "the good effects long ascribed to certain remedies of the active diuretic kind may be probably explained; such remedies appearing to possess the power, when given in favourable conditions of the system, of exciting the kidneys to separate large quantities of lithic acid; and in this way, by bringing about an artificial crisis, to produce great and immediate benefit."

---

[1] *Historia Naturalis*, lib. xxii. cap. 30.

The efficacy, in the lithic acid diathesis, of a mixture of turpentine and opium,[3] of muriatic acid and opium,[4] of the fruit (commonly called seeds) of the wild carrot, of the parsley breakstone (*Alchimilla arvensis*), of spiritus ætheris nitrici, of spiritus juniperi compositus, &c., may thus be in part explained. The beneficial effect of colchicum in gout has been ascribed to its causing the secretion of lithic acid.

2. *Alterative lithics*.—These are agents which alter the chemical qualities of the urine, and thereby prevent the formation of urinary deposits.

Some of them affect the urine by a direct chemical agency; that is, they become absorbed, are eliminated in the kidneys, and thus directly alter the chemical properties of the urine (see *ante*, p. 105). The alkaline and saline lithics act, in part at least, in this way; as do probably the acids also. Dr. Prout[5] states that "fluids containing the malic acid seem to possess peculiar powers in arresting the deposition of the phosphates in some individuals." Hence the beneficial influence, in many instances, of cider and perry. To this acid he also ascribes the solvent powers of Alchimilla arvensis.[6]

Some, on the other hand, indirectly alter the chemical qualities of the urine by the changes they effect in the vital processes of the animal economy. They modify the primary or secondary assimilation processes either by their influence over the nervous system, or otherwise. Opium and vegetable bitters oftentimes prove beneficial in deposits of the triple phosphates: the former allays nervous irritation; the latter is calculated to relieve debility.

3. *Lithonlytics; Lithonthryptics* or *Lithontriptics; Solvents for the stone*.—These have been employed in two ways—viz. by the mouth and by injection into the bladder.

α. Lithonlytics by the mouth.

"A perfectly healthy condition of the urine," says Dr. Prout,[7] "is not only one of the most natural, but probably also one of the most powerful solvents for all the ingredients likely to exist in urinary calculi that we can hope to possess. So satisfied am I of the general truth of this remark, that my belief is, that there is scarcely any form of stone that would long bear the continued action of healthy urine without becoming more or less dissolved or disintegrated." Admitting this to be true, it follows that the most rational mode of effecting the solution of urinary calculi is by promoting the copious secretion of healthy urine.

---

[1] The existence of lithic acid in the blood in gout, and its diminution or absence in the urine immediately preceding the gouty paroxysm, have been recently proved by Dr. Garrod (*London Medical Gazette*, Feb. 25, 1848).

[2] *On the Nature and Treatment of Stomach and Urinary Diseases*, 3d edit. p. 227, 1840.

[3] Dr. Henry (*Med.-Chirurg. Trans.* vol. x. p. 136) says that a remedy apparently composed of turpentine and laudanum has sometimes brought away several ounces of lithic acid in the course of a day or two.

[4] Opium is useful in these cases "not only on account of its sedative properties, but from the property which it likewise possesses of increasing the secretion of lithic acid." (Prout.) When the lithic acid is disposed to come away in the form of gravel, Dr. Prout advises the use of a combination of muriatic acid and opium; but when it is disposed to concrete he substitutes the liquor potassæ for the acid.

[5] *Op. ante cit.* p. 283.

[6] *Philosophical Transactions* for 1843, p. 8.

[7] *Op. ante cit.* p. 452.

In health the transparency of the urine is scarcely affected by the cooling of this liquid, a few nebulæ of mucus being alone deposited. When, however, the solid constituents of this secretion exist in an absolute or relative excess, the urine is either turbid when voided, or becomes so on cooling. It is obvious, therefore, that in the latter state it is unfitted for acting as a solvent of urinary calculi, as it is already saturated. In such cases water becomes a valuable agent. It dilutes the urine, and enables it not only to retain in solution, on cooling, the ordinary constituents of this secretion, but to act as a solvent of calculi. Hence, then, a copious use of aqueous fluids is an indispensable adjuvant of all lithontriptics. Even the long-continued action of large quantities of simple water on urinary calculi is capable apparently of disintegrating, and, in some cases, of dissolving them.[1]

Bourchardat[2] asserts that water is the best lithontriptic, and states that great water-drinkers are never afflicted with urinary calculi. He also insists "that lithontriptics are in general really and surely useful only when the urine remains limpid on cooling."

The great majority of agents employed as solvents for the stone are either acid or alkaline: the former being employed in phosphatic deposits; the latter in the lithic acid diathesis. But as healthy urine contains no free and uncombined alkaline or acid ingredient, Dr. Prout concludes that lithonlytics "are to be sought for among a class of harmless and unirritating compounds, the elements of which are so associated as to act at the same time, with respect to calculous ingredients, both as alkalies and acids."

At present no substance of this kind is known; but the solutions of the super-carbonated alkalies, containing a great excess of carbonic acid, approach the nearest to them.

These are used in two forms, either as natural mineral waters or as artificial soda and potash waters. Of the latter, "the potash matters are preferable; and when the calculus is of the lithic acid variety, and the diathesis decided, from ʒss. to ʒj. of the carbonated alkali, and as much of the tartarised soda, may be dissolved in each bottle, which may be taken twice a day with an equal quantity of warm distilled water. On the other hand, when the concretions consist of the phosphates, and the urine is decidedly alkaline, the alkali may be omitted altogether, and the compound may either consist of distilled water impregnated with carbonic acid gas, or occasionally some acid, as the nitric, may be substituted for the alkali" (Prout).

Of the natural mineral waters those of Vichy[3] have been most noted for the cure of stone and gravel. They contain super-carbonate of soda, and, when taken internally, render the urine alkaline. The Malvern water,—principally by its purity, partly also by the minute quantity of alkali which it contains,—is useful in lithic acid deposits.

---

[1] Chevallier, *Essai sur la Dissolution de la Gravelle et des Calculs de la Vessie*, Paris, 1837; also, *Lond. Med. Gaz.* vol. xx. p. 431.

[2] *Nouveau Formulaire Magistral*, p. 224, 3me édit. 1845.

[3] These waters, which were vaunted as solvents for stone by M. Petit, have of late years been the subject of numerous discussions among French physicians (see *Bulletin de l'Academie Royale de Médecine*, t. v. p. 60, for 1840; also, *British and Foreign Medical Review* for October 1841). "At the present time," says M. Mérat (*Supplément au Dictionnaire Univ. de Matière Médicale*,

Lime-water and soap have been much celebrated as solvents for urinary calculi.[1] They are the chief active ingredients in Miss Joanna Stephens's *Receipt for the Stone and Gravel.*[2] Notwithstanding the favourable reports to the contrary,[3] it appears to me that no rational ground of hope can now be entertained that lime-water is capable of dissolving urinary calculi in the kidneys or bladder; but there is abundant evidence to prove that patients afflicted with the uric acid diathesis have sometimes experienced extraordinary benefit from its use.[4] Chevallier[5] accounts for its efficacy in the treatment of gravel and stone by the circumstance of the combination of the lime with uric acid forming a very soluble salt, viz. urate of lime; and he even thinks that lime-water may be useful in phosphatic calculi, either by depriving them of a portion of the uric acid which they contain, and thus rendering them less dense; by decomposing the ammoniacal salt which enters into the composition of some; or by acting on the animal matter which holds the molecules of these calculi together.

Borax and phosphate of soda are other lithonlytics which have been used in consequence of their solutions acting as good solvents for lithic acid.

The acids likewise have been used to modify the renal secretion. Though they are secreted by the kidneys in combination with a base (see *ante*, p. 176), and do not, therefore, react in the urine as free acids, yet they are occasionally useful in calculous complaints.

In conclusion it may be observed, that while in several instances marked benefit and relief have been obtained by substances administered by the mouth under the name of lithonthryptics, no confidence can be placed in the solvent powers of any agent hitherto employed. The relief obtained in several

---

p. 736, 1846), "the patients at Vichy are divided into two parties: one, consisting of the gouty invalids, under the direction of M. Petit, who have faith in the waters; the other, under that of M. Prunelle, who are afraid of them. We believe," adds M. Mérat, "that M. Petit has given up his notions about the solution of gravel and calculi, and that he now holds the same opinion as his master [M. Prunelle], that the Vichy waters merely cause the expulsion of urinary concretions."

[1] See Dr. Whytt's *Essay on the Virtues of Lime Water and Soap in the Cure of the Stone*, Edinb. 1752.—He relied on about an ounce of Castile soap and two or three pints of lime-water in the course of twenty-four hours.

[2] As this lady acquired no slight fame by her mode of treatment, a great desire was manifested to know the nature of her remedies, which she offered to discover on the payment of a suitable reward. A committee of professional men was appointed to examine the efficacy of her treatment, and her medicines were given to patients known to have calculi. The report made by the committee (*Gentleman's Magazine* for 1740, vol. x. p. 185) as to the effects was so favourable, that Parliament was induced to grant a reward of £5000, a notice of which appeared in the *London Gazette* of March 18, 1739! (D'Escherny, *A Treatise of the Causes and Symptoms of the Stone*, 1755.) The essential parts of her remedies were lime (prepared by calcining egg-shells and snails), soap, and some aromatic bitters, viz. camomile flowers, sweet fennel, parsley, burdock leaves, &c. (*Gentleman's Magazine* for 1739, vol. ix. p. 298). That the patients submitted to treatment obtained relief by the remedies employed cannot, I think, be doubted, but no cure was effected; that is, no calculus was dissolved, for in the bladder of each of the four persons whose cure was certified by the trustees, the stone was found after their death (Alston's *Lect. on the Mat. Med.* vol. i. p. 268, Lond. 1770).

[3] Chevallier, *Lond. Med. Gaz.* vol. xx. p. 460.

[4] Van Swieten's *Commentaries upon Boerhaave's Aphorisms*, vol. xvi. p. 299.

[5] *Lond. Med. Gaz.* vol. xx. p. 584.

instances has been derived, not from the solution of the calculi, but from the diminution of pain and irritation in the urinary organs.

It deserves also to be noticed, that all the medicines which are reported to have been successfully administered by the mouth for the solution of urinary calculi, belong to the class of alkaline substances; and that the secret of their success seems to have been their plentiful dilution with aqueous liquids. Provided this be attended to, it is probable that the carbonated alkalies are as good lithonlytics as the caustic alkalies, while they are much less obnoxious to the digestive organs.

β. Lithonlytics injected into the bladder.—The direct and certain mode of bringing solvents in contact with calculi contained within the bladder, is by injection. But the objection to this mode of proceeding is, that the introduction of chemical agents, sufficiently strong to exert much influence over the calculi, into the bladder, would be attended with dangerous irritation to the vesical coats. This plausible objection has not, however, in all cases been found to hold good. On the contrary, lithonlytic injections into the bladder have, in some instances, allayed irritation.

The substances which have been employed in this way are—lime-water, alkaline solutions, acid solutions, and a solution of nitro-saccharate of lead. Mr. Ure[1] has proposed to employ a solution of carbonate of lithia.

In several instances lime-water has been introduced into the bladder without inconvenience; and in one instance[2] it appears to have been successful, as it is stated that no relic of the stone was left. In this case about five ounces of lime-water were introduced twice daily for ten weeks.

Alkaline solutions have also been used, and, in some cases, successfully. In one instance,[3] from three to six ounces of a solution of caustic potash, which hardly produced a feeling of warmth in the mouth at 98° Fahr., was introduced twice daily, and is said to have effected a perfect cure. In another case,[4] a solution of 115 grains of bicarbonate of soda to the wine pint of water rendered the fragments of an uric acid calculus so friable that very slight pressure was sufficient to break them.

Water acidulated with hydrochloric, sulphuric, or nitric acid, has been tried in several instances, and, in some, with success. Sir. B. Brodie[5] employed water acidulated with two or two and a half minims of nitric acid to every ounce of distilled water. The injection was used for from fifteen to thirty minutes every two or three days. The symptoms were relieved and a phosphatic calculus dissolved. In another case,[6] water containing a small portion of nitric acid (from $\frac{4}{100}$ths to $\frac{5}{100}$ths) has been injected with success.

More recently, Dr. Hosken[7] has used a solution of nitro-saccharate of lead.[8]

---

[1] *Pharmaceutical Journal*, vol. iii. p. 71. Carbonate of lithia is a constituent of several German mineral waters which have been found serviceable in affections of the urinary organs. One part of carbonate of lithia is soluble in 100 parts of water at 60° Fahr.

[2] W. Butter, *Method of Cure for the Stone, chiefly by Injections*, 12mo. Edinb. 1754.

[3] Ritter, in Hufeland's *Journal*, Bd. xxv.; also, *British and Foreign Medical Review*, vol. xii. pp. 399—400, 1841.

[4] *Comptes Rendus*, March 21, 1842.

[5] *London Medical Gazette*, June 18, 1831.

[6] *Comptes Rendus*, March 21, 1842.

[7] *Phil. Trans.* for 1843.

[8] Nitro-saccharate of lead was thus prepared. Pulverised saccharate of lead was dissolved in a sufficient quantity of cold dilute nitric acid (one acid to nineteen water). By filtration and gradual evaporation, amber-coloured crystals of nitro-saccharate of lead were obtained.

The solution consisted of one grain of nitro-saccharate of lead "moistened with five drops of pure saccharic acid, and dissolved in a fluid-ounce of distilled water." The liquid thus obtained was bland, without any astringency, but had a slight acid reaction. It decomposed phosphatic calculi, and caused the deposition of phosphate of lead. When injected into the bladder rendered morbidly irritable by the presence of stone, it was freely tolerated.

Even simple water injected into the bladder daily for several months has appeared to have partially dissolved and disintegrated a phosphatic calculus.[1]

On the whole, it is obvious that sufficient success has been obtained by the injection of lithonlytic liquids into the bladder, to warrant further experiments and perseverance in this method of treatment.

Class IX. *Genetica.* Medicines acting on the Sexual Organs.

Medicines which act on the sexual organs may be termed *genetica* (γενετικά; from γείνομαι, *I am begotten* or *I beget:* whence γένεσις, *origin, generation*).

This class includes the medicinal agents supposed to affect the venereal orgasm, and those which act on the uterus.

1. *Affecting the orgasm.*

The existence of medicinal agents endowed with specific aphrodisiac or anaphrodisiac powers has been denied by some, and admitted by others. Most modern systematic writers on pharmacology have agreed with Dr. Cullen[2] in the belief of the non-existence of agents of this kind; and therefore, in recent works on Materia Medica, aphrodisiacs and anaphrodisiacs are, as distinct classes or orders, unnoticed.

But it appears to me that Dr. Cullen's opinion is scarcely supported by fact. That the sexual feelings and powers may be influenced directly or indirectly by substances taken into the stomach, cannot, I think, be doubted. The aphrodisiac property of phosphorus, for example, has been recognised both in man and the lower animals; and there is reason to believe that some other agents, as Indian hemp, act in the same way. The refrigerant and anaphrodisiac effects of nauseants and drastics are well known.

From time immemorial a belief has existed in the aphrodisiac and anaphrodisiac properties of certain dietetical and medicinal agents;[3] and though the popular opinion may be in many cases erroneous, there is reason to suspect that it has some foundation in fact. Such agents would probably prove more influential on the susceptible nervous system of inhabitants of warm than of cold climates.

In practice, cases not unfrequently occur in which aphrodisiac or anaphrodisiac agents are indicated, and in which medicinal substances are given with the view of producing the one or the other of these effects. It appears to me, therefore, that a brief enumeration of substances reputed to possess aphrodisiac or anaphrodisiac properties may not be uninteresting or useless.

---

[1] *British and Foreign Medical Review*, vol. xii. p. 400.

[2] *Treatise of the Materia Medica*, vol. i. p. 171, Edinb. 1789.

[3] For a list of such substances, see Virey's memoir *Des Médicamens Aphrodisiaques en général, et en particulier sur le Dudaim de la Bible*, in the *Bullet. de Pharmacie*, t. v. p. 193, 1813.

ORDER 1. APHRODISIACA (ἀφροδισιακά; from ἀφροδίσια, *venery*).—Medicines which are supposed to excite the sexual feelings, or to increase the venereal powers, are called *aphrodisiacs*.

Various odoraments, as musk, castoreum, civet, and ambergris,[1] have been employed as sexual stimulants. Several intoxicating agents, especially wine, Indian hemp, and opium, have been used as aphrodisiacs; but it is doubtful whether any of them increase the sexual powers, though they may inflame the imagination and excite desire; wine is well known to diminish them. Nux vomica appears to be a sexual stimulant Spices (see *ante*, p. 224); the alliaceous and cruciferous stimuli which contain the allyle oils (see *ante*, p. 225); some of the resinous stimulants, as the turpentines and the fetid gum-resins; phosphorus; cantharides; emmenagogues, as borax and aristolochia; the chalybeates; and certain dietetical substances, such as fish,[1] shell-fish, salt, and leguminous seeds, are reputed aphrodisiacs, and some of them may, perhaps, under certain circumstances, occasionally act as such.

ORDER 2. ANAPHRODISIACA (ἀναφροδισιακά; from ἀναφροδισία, *absence of the sexual feelings*).—Medicinal agents which are supposed to take away or repress the sexual feelings are called *anaphrodisiacs* or *antaphrodisiacs*.

Nauseants (as emetic tartar) and drastic cathartics act as anaphrodisiacs. Carbonate of soda and soda water are also said to possess similar properties; as well as hemlock. Camphor has been long in repute as an anaphrodisiac; and by the school of Salernum it was said that "*camphora per nares castrat odore mares.*" Trousseau and Pidoux[3] experienced temporary anaphrodisia from 36 grains of this substance.

Many other substances are reputed anaphrodisiacs, but on insufficient evidence. Such are the aromatic labiate plants, coffee (which has been called *potus caponum*), cucurbitaceous plants, lettuce, &c. &c.

2. *Affecting the uterus.*

(Uterina.)

This division includes two orders of medicinal agents, *emmenagogues* and *ecbolics*.

ORDER 3. EMMENAGOGA (ἐμμηναγωγά; from ἐμμήνια, *the menstrual discharge*, and ἀγωγός, *eliciting* or *evoking*); *Menagoga*.—Medicines which excite or promote the catamenia are denominated *emmenagogues*.

As the suppression or retention of the catamenia may be occasioned by very different circumstances, no one agent can be expected to prove emmenagogue in all, or even in many cases. Deficient menstruation is rarely, perhaps, an idiopathic disease, but in general a morbid symptom merely; and therefore those agents which remove it must be relative, that is, must have reference to the disease which produces it.

---

[1] Prosper Alpinus (*De Medicina Ægyptiorum*, lib. iii. cap. xv.) states that the Egyptian women use unguents containing musk, ambergris, aloes, and civet, "ad coeuntibus voluptatem conciliandam."

[2] The popular notion that those who live principally on fish, are unusually prolific, appears to be erroneous. (See my *Treatise on Food and Diet*, p. 282.)

[3] *Traité de Thérapeutique*, t. i. p. 48, Paris, 1836. These authors mention, as the characteristic of the anaphrodisia produced by camphor, "l'imperfection de l'érection."

When amenorrhœa coexists with anæmia, the most effectual emmenagogues are the chalybeates (see *ante*, p. 194). In most cases it will be found advisable to conjoin aloetic purges. In hysterical amenorrhœa unaccompanied by anæmia, ammonia, the fetid gum-resins, castoreum, cubebs, &c., prove indirectly emmenagogue. Here also aloetic purges frequently prove serviceable. When amenorrhœa occurs in plethoric habits, blood-letting and active cathartics act indirectly as emmenagogues.

But the term emmenagogue is usually employed in a more limited sense,—namely, to indicate those substances which are supposed to possess a specific power of affecting the uterus, and thereby of promoting the catamenial discharge. There are, however, few bodies to which this definition can be strictly applied. Indeed, two reasons have led some pharmacological writers to doubt the existence of any medicines which can be properly termed specific emmenagogues,—namely, the uncertainty of all the means so named, and the uterus not being an organ intended for the excretion of foreign matters.

The substances usually regarded as specific emmenagogues are, for the most part, medicines which, when taken in large doses, act as drastic purgatives. Such are savin, black hellebore, aloes, gamboge, &c. They excite the pelvic circulation, give rise to a sensation of bearing down of the womb, especially in females disposed to procidentia uteri, increase uterine hemorrhage or the menstrual discharge when given during these conditions, and, when administered in chlorosis or amenorrhœa, sometimes bring on the catamenia.

Stimulating diuretics extend their exciting influence by contiguous sympathy to the uterus, and thus often act as emmenagogues. Gin, which is frequently employed by females to excite the menstrual discharge, appears to act in this way. I have known abortion produced by cantharides given as an emmenagogue.

Rue is a reputed and popular emmenagogue. It possesses cerebro-spinal properties, and has on several occasions produced miscarriage.

Madder was a favourite emmenagogue with the late Dr. Home,[1] who declared it to be the strongest and safest known.

Stinking goosefoot or stinking orache (*Chenopodium olidum*) is not unfrequently used by females as an emmenagogue. It is sold by herbalists, and is in sufficient demand to induce the herb-growers at Mitcham to cultivate it.

Ergot of rye possesses an unequivocal influence over the uterus. But it rather promotes uterine contractions than the menstrual function, though it has on many occasions been successfully employed in amenorrhœa.

Borax is a stimulant to the uterus, and sometimes proves emmenagogue.

Mercurials and iodide of potassium promote the catamenia in common with the secretions generally.

Aristolochia was formerly in use as an emmenagogue.

ORDER 4. ECBOLICA (from ἐκβόλιον, *a medicine which causes abortion* or *the expulsion of the fœtus*); *abortiva*; *amblotica* (ἀμβλωτικά); *amblothridia* (ἀμβλωθρίδια).—Medicines which excite uterine contractions, and thereby promote the expulsion of the contents of the uterus, are called *ecbolics.*

---

[1] *Clinical Experiments*, p. 422, 2d edition, Lond.

Ecbolics are essentially distinguished from emmenagogues by this circumstance, that while the latter stimulate the vascular system of the uterus, the former excite the uterine muscular fibres. Ecbolics, therefore, promote the expulsion of substances contained in the uterine cavity; such as the fœtus, the placenta, hydatids, clots of blood, &c.

The number of ecbolics known is very small. Indeed, the only unequivocal agent of this kind is ergot. The ergot in ordinary use is that of rye, but the ergot of wheat is equally effectual, and the same perhaps may be stated of the ergot of all grasses.

Borax is said to act as an ecbolic.[1]

Div. II.—Special Pharmacology.

Special Pharmacology treats of medicines individually. These I shall arrange in two groups, called respectively the *inorganic* and the *organic;* the former of which will be subdivided according to the chemical relations of its members, the latter according to their external, or, as they are usually termed, natural history characters.

Objections may be raised to this mixed system of classification; but in the present state of science, an arrangement founded exclusively either on external or on chemical characters, must be most unsatisfactory. Our knowledge is as yet too incomplete to allow us to follow either principle exclusively; and some of the most recent writers[2] on mineralogy admit the insufficiency of external characters for the determination of all mineral species. I cannot admit the propriety of limiting the term natural history characters to external properties only, and of excluding chemical characters from the means employed to distinguish natural bodies.[3] The best and most perfect classification would be obviously that which is founded on a consideration of *all* the properties.

The division of medicines into inorganic and organic is not free from objections, nor without difficulties; for there are some substances which might with equal propriety be referred to either group, since they are composed both of inorganic and of organic compounds.[4] Such are metallic salts composed of a metallic oxide and an organic acid. These bodies are usually referred to organic substances; but as in most cases their medicinal properties are allied to those of the inorganic salts of the same metals, it will be more convenient and natural for me to consider them among inorganic substances.

---

[1] [We are acquainted with the history of a case in which borax taken daily in ounce doses acted as an ecbolic. Great hemorrhage followed, but the patient eventually recovered.—Ed.]

[2] *Report on the Recent Progress and Present State of Mineralogy*, by W. Whewell, M.A. (In the *Report of the First and Second Meetings of the British Association*, Lond. 1833).—*A System of Mineralogy*, by J. D. Dana, A.M., p. 18, 2d edit. New York, 1844.

[3] Glocker, in his *Generum et Specierum Mineralium secundum Ordines Naturales digestorum Synopsis* (Halæ Saxonum, 1847), has arranged minerals in eighteen orders, which he calls *natural*, the characters of many of which are wholly chemical. These orders are contained in five classes exclusively founded on the chemical nature of the substances. It is obvious, therefore, that the author includes chemical properties among natural history characters.

[4] "Organic compounds," says Leopold Gmelin (*Handbuch der Chemie*, 4ter Bd. p. 4, 1848), "are simple compounds containing more than one atom of carbon." By the term simple compounds are meant those which cannot be formed of other compounds. Such substances as bicarbonate of potash are, therefore, obviously excluded.

I. INORGANIC BODIES.

Of the *inorganic* or *anorganic* substances used in medicine some are simple, others are compound.

At the present time (May 1854) sixty-two simple or elementary substances are known; and of these, thirteen are called non-metallic bodies, and forty-nine are termed metals.

NON-METALLIC BODIES OR METALLOIDS.

1. Oxygen.
2. Hydrogen.
3. Carbon.
4. Boron.
5. Silicon.
6. Phosphorus.
7. Sulphur.
8. Selenium.
9. Iodine.
10. Bromine.
11. Chlorine.
12. Fluorine.
13. Nitrogen.

METALS.

14. Kalium.
15. Natrium.
16. Lithium.
17. Barium.
18. Strontium.
19. Calcium.
20. Magnesium.
21. Cerium.
22. Lanthanium.
23. Didymium.
24. Yttrium.
25. Terbium.
26. Erbium.
27. Glucinum.
28. Aluminum.
29. Thorium.
30. Zirconium.
31. Norium.
32. Titanium.
33. Tantalum.
34. Niobium.
35. Pelopium.
36. Tungsten.
37. Molybdenum.
38. Vanadium.
39. Chromium.
40. Uranium.
41. Manganesium.
42. Arsenicum.
43. Antimonium.
44. Tellurium.
45. Bismuth.
46. Zinc.
47. Cadmium.
48. Tin.
49. Lead.
50. Iron.
51. Cobalt.
52. Nickel.
53. Copper.
54. Quicksilver.
55. Silver.
56. Gold.
57. Platinum.
58. Palladium.
59. Rhodium.
60. Iridium.
61. Osmium.
62. Ruthenium.

ORDER I. OXYGEN AND ITS AQUEOUS SOLUTION.

1. OXYGENIUM.—OXYGEN.

Symbol O. *Equivalent Weight* 8. *Equivalent Volume* 0·5 or □

HISTORY.—Oxygen gas was discovered on the 1st of August, 1774, by Dr. Priestley,[1] who denominated it *dephlogisticated air*. In the following year Scheele also discovered it, without knowing what Priestley had done, and he called it *empyreal air*. Condorcet termed it *vital air*. Lavoisier named it *oxygen* (from ὀξὺς, *acid*, and γεννάω, *I beget* or *produce*).

NATURAL HISTORY.—Oxygen is found in both kingdoms of nature.

a. IN THE INORGANISED KINGDOM.—Oxygen is, of all substances, that which is found in the largest quantity in nature, for it constitutes at least three-fourths of the known terraqueous globe. Thus water contains eight-ninths of its weight of oxygen; and the solid crust of our globe probably consists of at least one-third part, by weight, of the principle; for silica, carbonate of lime, and alumina—the three most abundant constituents of the earth's strata—contain each about half their weight of oxygen. Sir H. De la Beche[2] calculates that silica alone constitutes "forty-five per cent. of the mineral crust of our globe." Of the atmosphere, oxygen constitutes twenty or twenty-one per cent. by volume, or about twenty-three per cent. by weight, to which must be added eight-ninths, by weight, of the atmospheric aqueous vapour.

---

[1] *Experiments and Observations on different kinds of Air*, vol. ii. p. 06, Birmingham, 1790.

[2] *Researches in Theoretical Geology*, p. 8, Lond. 1834.

β. IN THE ORGANISED KINGDOM.—Oxygen is an essential constituent of all living bodies. It is disengaged by plants and absorbed by animals. The former obtain it by the decomposition of water and carbonic acid; the latter consume it in the oxidisement of hydrogen and carbon, and the consequent formation of water and carbonic acid. Thus the two kingdoms of the organised world bear an important relation to each other. Vegetables may have been the original producers of atmospheric oxygen, as they are now the purifiers of the air. In the sun's rays they absorb carbonic acid, decompose it, retain the carbon, and emit the oxygen.

PREPARATION.—There are several methods of procuring this gas:—

1. *By heating chlorate of potash.*—This method yields pure oxygen gas. Theoretically 100 grs. of chlorate should evolve 39·183 grs. (=114·6 cub. inches at 60° F. and 30′ bar.) of pure oxygen gas. (From 100 grains of the chlorate we may expect to obtain nearly 100 cubic inches of the gas. —*Brande*). One equivalent of chlorate of potash yields six equivalents of oxygen and one equivalent of chloride of potassium. $KO,ClO^5 = KCl + O^6$.

MATERIAL.	COMPOSITION.		PRODUCTS.
1 eq. Chlorate of Potash...122·5	1 *eq. Chloric Acid* 75·5	5 *eq. Oxygen*...40	6 eq. Oxygen 4
		1 *eq. Chlorine* .35·5	
	1 *eq. Potash* 47	1 *eq. Oxygen*...8	
		1 *eq. Potassium* 39	1 eq. Chloride Potassium 74·5
	122·5	122·5	122·5

The process is greatly facilitated by intimately mixing the powdered chlorate with from $\frac{1}{10}$ to $\frac{1}{4}$ of its weight of powdered binoxide of manganese. A very moderate heat is then sufficient to cause the decomposition of the chlorate and the evolution of oxygen gas. The mixture soon begins to glow, and the gas is given out with great rapidity. The binoxide appears to act mechanically and by contact, like iron filings in facilitating the boiling of water; for it does not necessarily undergo any chemical change during the process; and other substances, as oxide of copper, may be substituted for it.

As thus modified, this is by far the most convenient of the different methods of preparing oxygen gas. The process may be conducted in a glass retort or flask to which a bent tube is adapted by means of a perforated cork. Retorts or flasks made of glass without lead are to be preferred. A spirit or oil lamp is used to heat the mixture.

2. *By heating binoxide of manganese in an iron bottle.*—This is the cheapest method; and, for ordinary purposes, it yields oxygen gas sufficiently pure. The common black oxide of manganese of commerce, called by mineralogists *pyrolusite*, is an impure binoxide. When subjected to heat, it first evolves water in the form of steam, frequently carbonic acid (from the presence of an earthy carbonate), and afterwards oxygen gas. To remove traces of carbonic acid, the gas may be washed with lime-water or a solution of caustic potash; but if the first products be allowed to escape, this proceeding is unnecessary. One of the malleable iron bottles in which mercury is imported from Spain may be conveniently employed for igniting the oxide, a piece of curved iron gas tubing being screwed into it.

By heat the binoxide loses part of its oxygen, and becomes converted into the sesquioxide. $2MnO^2 = O + Mn^2O^3$. By a stronger heat a portion of the sesquioxide is converted into protoxide, leaving a compound of sesquioxide and protoxide. The conversion of binoxide into this compound may be thus expressed: $3MnO^2=2O+Mn^2O^3, MnO$.

MATERIAL.	PRODUCTS.	
3 eq. Binoxide Manganese = 132	2 eq. Oxygen	16
	1 eq. Sesquioxide Manganese	80
	1 eq. Protoxide Manganese	36
		132

As 132 grs. of pure binoxide yield 16 grs. of oxygen, 1 lb. avoirdupois will yield about 848½ grs., or 71½ imperial pints. One pound of common commercial black oxide usually yields from 30 to 40 pints; but, from fine samples, from 40 to 50 pints may be procured.

The preceding are the usual methods of procuring oxygen. The following are other modes of obtaining it, but they are seldom resorted to.

1. By heating the black oxide of manganese with its own weight of oil of vitriol in a glass retort. The products are sulphate of the protoxide of manganese, water, and oxygen, $MnO^2+HO,SO^3=MnO,SO^3+HO+O$.

2. By heating three parts of powdered bichromate of potash with four parts of oil of vitriol in a glass retort.[1] The products are sulphate of potash, sulphate of the sesquioxide of chromium, water, and oxygen, $KO,2CrO^3+4(HO,SO^3)=KO,SO^3+Cr^2O^3, 3SO^3+4HO+3O$.

3. By igniting the red oxide of mercury. The products are metallic mercury and oxygen.

4. By igniting nitrate of potash. The products are hyponitrite of potash and oxygen, $KO,NO^5=KO,NO^3+2O$.

PROPERTIES.—It is elastic, colourless, odourless, tasteless, incombustible, but a powerful supporter of combustion. According to Regnault, 100 cubic inches of this gas weigh, at the temperature of 60° F., and when the barometer stands at 30 inches, 34·19 grains: and its specific gravity is 1·1056. (According to Berzelius and Dulong, the sp. gr. is 1·1026.)

Characteristics.—Free oxygen gas, either pure or in a gaseous mixture, is recognised by the following characters:—

α. When binoxide of nitrogen is mingled with it, yellowish or ruddy fumes of hyponitric acid are produced.

β. When mixed with twice its volume of hydrogen, and the mixture is exploded in the eudiometer, water only is the product. The diminution of volume divided by 3 indicates the amount of oxygen present.

Oxygen gas, when absolutely or tolerably pure, rekindles a wood match or taper which is red with heat but without flame. The only gas likely to be confounded with oxygen in this respect is the protoxide of nitrogen, from which oxygen is distinguished by the characters above mentioned.

The presence of free oxygen in mineral waters is detected by the sulphate of the protoxide of iron. A bottle being nearly filled with the water, a solution of this salt is to be added, and the vessel immediately stopped, care being taken that every bubble of air be excluded. If oxygen be present, a yellowish-brown precipitate (sesquioxide of iron) is produced. Some persons add a few drops of liquor potassæ to the mixture: if no free oxygen be present, a bluish precipitate (hydrated protoxide of iron) is formed; but if there be oxygen, a yellowish-brown precipitate (sesquioxide of iron) occurs.

Combined oxygen is recognised thus. The oxides of the noble metals are reduced by heat, oxygen gas being set free. The oxides of the ignoble metals, when mixed with carbon and ignited, are reduced, carbonic oxide or carbonic acid being evolved. Every volume of carbonic oxide contains half a volume of oxygen, and every volume of carbonic acid its own volume of oxygen. The oxides of potassium and sodium are also reduced by carbon and heat, carbonic oxide being evolved. Potassium decomposes (either at common temperatures or at a red heat) most compounds containing oxygen, and becomes converted into potash; and it is sometimes useful for detecting the presence of oxygen. In organic analysis, the amount of oxygen contained in the organic substance is estimated from the loss, and is, therefore, liable to fallacy.[1]

---

[1] Balmain, *Pharmaceutical Journal*, vol. ii. p. 92.

PHYSIOLOGICAL EFFECTS. α. *On Vegetables.*—Oxygen gas is essential to the germination of seeds and to the existence and growth of plants. Edwards[2] says, that seeds, in germinating, decompose water to obtain oxygen. In the shade, vegetables absorb it from the atmosphere and evolve an equal volume of carbonic acid; while, in the solar rays, the reverse changes take place, carbonic acid being absorbed and oxygen expired. The vigorous growth of plants in inclosed cases, as originally proposed and practised by my friend Mr. N. B. Ward,[3] does not invalidate the above statements; since the cases are never completely air-tight, but allow the ingress and egress of air consequent on changes of temperature. The quantity of oxygen required for the growth of some plants, however, appears to be much smaller than was previously supposed.

The effects of pure oxygen gas on germination and vegetation have been examined by Theod. de Saussure.[4] He found that the period of germination is the same in oxygen gas as in atmospheric air, but that seeds evolve more carbonic acid in the former than in the latter. Plants do not thrive so well in an atmosphere of oxygen gas in the shade as in one of common air; they give out more carbonic acid, which is always injurious to vegetation in the shade. When exposed in oxygen gas to the direct rays of the sun, they augment in weight about as much as in atmospheric air.

β. *On Animals generally.*—It is usually asserted that all animals require the influence of oxygen, or rather of air, to enable them to exist; but this assertion cannot be proved in the case of some of the lower animals. Thus intestinal worms seem to dispense with respiration.[5] Some animals which respire have no organs especially devoted to this function; in these the

---

[1] To illustrate the nature of the fallacy alluded to in the text, the analysis of cystic oxide may be quoted. This organic substance was analysed by Dr. Prout (*Med.-Chir. Trans.* vol. ix. p. 480), who found that it contained in 100 parts

Carbon	29·875
Hydrogen	5·125
Nitrogen	11·850
	46·850
Deficiency	53·150
	100·000

He therefore placed the deficiency to the account of oxygen. Now it has been more recently ascertained by Thaulow (*Ann. der Chem. u. Pharm.* xxvii.), that about one-half of this deficiency is due to sulphur.

[2] *Athenæum*, Feb. 2, 1839.

[3] *Companion to the Botanical Magazine for May* 1836.

[4] *Recherches Chimiques sur la Végétation*, pp. 11, 12, and 93, Paris, 1804.

[5] Müller's *Physiology*, by Baly, vol. i. p. 295.

cutaneous surface effects respiration; as in the *Polypifera*. In the *Infusoria* the respiratory organs are delicate cilia. Many animals have branchiæ, or gills, for respiration, as some *Mollusca*, some *Annelida*, and fishes. Leeches respire by subcutaneous sacs, which open externally. The respiratory organs of insects are ramifying tracheæ. Lastly, the higher classes of animals, as the Mammals, respire by means of lungs. Whenever respiration is effected, a portion of oxygen disappears, while a quantity of carbonic acid, nearly equal in volume to the oxygen consumed, is produced.

The continued respiration of oxygen gas is injurious and even fatal to animal life: this has been observed by all experimenters. Animals live longer in a given volume of oxygen than in the same quantity of atmospheric air, but the continued employment of it causes death. Mr. Broughton confined rabbits, guinea-pigs, and sparrows, in glass jars containing oxygen, and inverted over water. At first they suffered no inconvenience, but in about an hour their breathing became hurried and the circulation accelerated. This state of excitement was followed by one of debility; the respirations became feeble, and were more slowly performed; loss of sensibility and of the power of voluntary motion supervened, till the only remaining visible action was a slight one of the diaphragm, occurring at distant intervals. On opening the body, the blood (both venous and arterial) was found to be of a bright scarlet hue; it was thin, and rapidly coagulated. The gas in which animals had thus been confined till they died, retained its power of rekindling a blown-out taper, and of sustaining for a time the life of another animal introduced into it; and Mr. Broughton hence deduced the inference that it does not contain so great an excess of carbonic acid as the gas left when animals have perished by confinement in atmospheric air; and he considered the train of symptoms induced by the respiration of pure oxygen gas as analogous to those which follow the absorption of certain poisons into the system.[1] Injected into the pleura, oxygen gas is very quickly absorbed, without producing inflammation. Cautiously injected into the veins of dogs, it has no sensible effect on the system.[2]

γ. *On Man.*—If pure oxygen be inspired a few times it does not produce any remarkable phenomena; though some have ascribed various effects to it, such as agreeable lightness in the chest, exhilaration, increased frequency of pulse, a sensation of warmth in the chest, gentle perspiration, and an inflammatory state of the system. But several of these results arise probably from mental influence, others from the mode of inhaling the gas, and perhaps some might depend on the employment of impure oxygen.

USES.—Soon after the discovery of oxygen, the most exaggerated notions prevailed as to its remedial powers. Various diseases (scorbutus, for example) were thought to be dependent on a deficiency of it; and it was, in consequence, submitted to a considerable number of trials, with, as it was at first asserted, remarkable success. But Chaptal[3] and Fourcroy[4] declared that it was injurious in phthisis. In England it was tried by Beddoes[5] and Hill[6]. The latter states that he found it beneficial in asthma, debility, ulcers, gangrene, white swelling, and scrofulous diseases of the bones. The beneficial results obtained by the use of acids (especially nitric acid), of the oxides of mercury, chlorate of potash, vegetable food, &c. were referred to the oxygen which these substances contained, and which they were supposed to communicate to the system. These notions are now exploded.[1]

---

[1] *London Medical Gazette*, vol. iii. p. 775.

[2] Nysten, *Recherches de Physiologie*, p. 60, Paris, 1811.

[3] *Annales de Chimie*, t. iv. p. 21.

[4] *Ibid.* t. iv. p. 83.

[5] *Considerations on the Medicinal Use of Factitious Airs, and on the Manner of obtaining them in large quantities.* By T. Beddoes and James Watt. Bristol, 1794–1795.

[6] *Practical Observations on the Use of Oxygen, or Vital Air, in the Cure of Diseases*, Lond. 1800.

In asphyxia arising from a deficiency of atmospheric air, or from breathing noxious vapours, the inhalation of oxygen gas has been said to be, and probably is, useful. On the same principle, it may be employed during an attack of spasmodic asthma when there is danger of suffocation; but it is at best only a palliative, and has no power of preventing the occurrence of other attacks. Chaussier[2] has recommended its use in children apparently still-born: I have known it used without benefit. To combat the asphyxia of malignant cholera, inhalations of oxygen were tried in Russia, Poland, Prussia, and France, but without success.[3] On the whole, then, I believe oxygen to be almost useless as a remedy.[4]

AQUA OXYGENII: *Oxygen Water.*—At the mean pressure and temperature of the atmosphere, 100 vols. of water dissolve, according to Dalton and Henry,[5] 3·7 vols. of oxygen gas; according to Saussure,[6] 6·5 vols. By pressure in a proper machine, water may be charged with a much larger quantity. This solution has been termed *oxygenated water*, but is a very different substance to the peroxide of hydrogen, which has also been known by this appellation (see *Hydrogenii binoxydum*). Neither is it to be confounded with Searle's *oxygenous aërated water*, which is an aqueous solution of the protoxide of nitrogen (see *Aqua nitrogenii protoxydi*). It has been used to the extent of one or two bottlefuls daily, as a slight excitant. It is said to increase the appetite and promote the secretions, and to be serviceable in spasm of the stomach, amenorrhœa, hysteria, atonic dropsy, &c.

[**OZONE.**—We have thought it right to introduce into this part of the work a notice of Ozone; a name given to what was once supposed to be a new elementary substance. Further observation has shown, however, that the reactions by which this supposed element was characterised are more correctly to be attributed to oxygen existing in a peculiar masked or modified condition. To this state of oxygen the term allotropic or ozonised is applied, and it must be remembered that when the word ozone is now used, it is merely as a conventional term for oxygen in the allotropic form.[7]

Ozone was discovered by Professor Schönbein, who described its properties, and considered it as an elementary substance. It was first recognised in the neighbourhood of electrical machines, or galvanic arrangements under excitement, where it could be recognised by its peculiar odour. This odour had been long known to those occupied in investigating electrical phenomena, but no importance appears to have been attached to it previous to the publication of Professor Schönbein's views. Recent research seems clearly to demonstrate, that when the oxygen contained in atmospheric air is exposed to the action of electricity, it assumes a modified state, and shows chemical reactions differing materially from those with which we ordinarily find it endowed. It is not indispensably necessary, however, that electricity should be present to effect this change, for there are several methods of bringing about the ozonised or allotropic condition, which bear no relation whatever to electricity. Thus if phosphorus be allowed to remain either in oxygen or atmospheric air for a few seconds, and the gas be washed well with water to remove all the acid produced, the change is effected, and the oxygen assumes peculiar characteristic properties. Again, if a few drops of ether be placed in oxygen, so that the vapour may ascend in the jar containing it, and a glass rod heated to somewhat less than a low red heat be introduced for a few seconds, the gas will be found to have assumed the allotropic state. The properties by which the allotropic oxygen is characterised are such as indicate a greatly increased power for combination: thus if silver leaf be exposed in such oxygen, it is immediately converted into oxide of silver, and falls in that form to the bottom of the containing vessel. Ozonised oxygen is a deodoriser, and possesses bleaching powers. Again, if paper moistened with a solution of iodide of potassium and starch be exposed to the gas, it is immediately changed to a blue colour, owing to a combination taking place between the potassium and the oxygen, and the consequent liberation of iodine. Papers prepared in this way are used by Schönbein to detect the presence of allotropic oxygen in atmospheric air, and, when prepared of different degrees of delicacy, constitute an ozonometric test.

---

[1] For further details respecting these opinions, see the *Dictionnaire Universel de Matière Médicale et de Thérapeutique Général*, par F. V. Mérat and E. J. De Lens, t. v. p. 136.

[2] *Histoire et Mémoires de la Société Royale de Médecine*, 1780–1781; *Hist.* p. 346.

[3] Mérat and De Lens, *op. supra cit.* t. v. p. 141.

[4] It is remarkable that electricity and oxygen, two agents of vast influence in nature, should possess but slight remedial power.

[5] *Elements of Experimental Chemistry*, vol. i. p. 255, 10th edit. London, 1826.

[6] *Ibid.*

[7] [For interesting and important information connected with the subject of allotropism, see *Faraday's Lectures, by Scoffern*, 1853.]

Oxygen is found in the allotropic state in atmospheric air that has passed any considerable distance over the sea, and it may also be detected in air which has passed over open country. The allotropic state of the atmospheric oxygen is immediately destroyed, however, if the air pass over a city, town, or crowded district of any kind.

From what has been stated above, it is evident that allotropic oxygen is necessary to the preservation of animal life in perfection, and that its presence must be valuable were it only as a deodoriser and disinfectant, both of which offices it fulfils in virtue of its greatly increased power for combination. The ascertainment of the varying force of atmospheric oxygen as a combiner, promises hereafter to become one of the most important subjects for consideration as regards the choice of climate in disease; and the mode of using Schönbein's papers for detecting its presence should be familiar to medical men.

The solution for impregnating the papers is prepared by boiling together 1 grain of iodide of potassium, and 10 grains of starch, in 200 grains of distilled water.[1] If bibulous paper be soaked in this and then dried, it shows, when moistened, very marked reactions, after exposure to an atmosphere containing allotropic oxygen. During exposure in the dry state to such an atmosphere, a change sometimes occurs in the liberation of free iodine, so that a brownish tint is observed: this, however, will turn to a blue colour if the paper be wetted.

---

[1] The proportions of water and of iodide are too small in this formula, and a more delicate paper can be made by adding 10 grs. of starch to 4 of iodide, and 1000 of water.

The peculiar exhilarating effect experienced on leaving crowded places and residing in the country, may in all probability be correctly attributed to the atmosphere containing oxygen in this state of increased activity. Chemistry fails to discover more oxygen in the air of the open country, or that of the sea-side, and equally fails to trace in varying conditions of heat or cold, moisture or dryness, the more invigorating effects of a country life. In the allotropic state of oxygen, however, we appear to have before us a solution of the difficulty. Those residing in cities and towns will do well to remember that in their drives and walks the most invigorating atmosphere is to be found to the windward of their homes, while many miles must be travelled before the oxygen of the air assumes its allotropic state to the leeward of a city or town. It is but reasonable to believe that attention to this fact will be of service in a hygienic point of view to the inhabitants of all crowded districts.—ED.]

ORDER II. HYDROGEN AND ITS COMPOUNDS WITH OXYGEN.

Two compounds only of hydrogen with oxygen are known; namely, the *protoxide of hydrogen*, or *water*, HO; and the *binoxide of hydrogen*, HO^2.

2. HYDROGENIUM.—HYDROGEN.

Symbol H. *Equivalent Weight* 1. *Equivalent Volume* 1 *or* □

HISTORY.—Cavendish,[1] in 1766, may be considered as the real discoverer of hydrogen, though it must have been occasionally procured, and some of its properties known, previously. He termed it *inflammable air*. Lavoisier called it hydrogen (from ὕδωρ, water, and γεννάω, *I beget* or *produce*), because it is the radicle or base of water.

NATURAL HISTORY.—It is found in both kingdoms of nature.

a. IN THE INORGANISED KINGDOM.—Next to oxygen it may be regarded as the most important constituent of the terraqueous globe. It constitutes 11·1 per cent. by weight of water. It is an essential constituent of some minerals (as coal, amber, and sal ammoniac), in which it does not exist as an element of water. The gas which is contained in the decrepitating rock salt of Wieliczka, in a very condensed state, is a mixture of hydrogen, carbonic oxide, and light carburetted hydrogen: the salt decrepitates when placed in water, owing to the disengagement of these gases. Lastly, it is evolved from volcanoes or from fissures in the earth, in combination with carbon, sulphur, chlorine, or nitrogen, under the forms of light carburetted hydrogen, sulphuretted hydrogen, hydrochloric acid, and ammonia.

β. IN THE ORGANISED KINGDOM.—Hydrogen is an essential constituent of all organised beings (animals and vegetables), either combined with oxygen, to form water, or otherwise. Certain fungi exhale hydrogen gas both night and day.[2]

PREPARATION.—Hydrogen is usually procured by the action of zinc on diluted sulphuric acid.

---

[1] *Phil. Trans.* vol. lvi. for the year 1766.

[2] De Candolle, *Phys. Vég.* tom. i. p. 459.

Add some granulated zinc to a mixture of 1 part of oil of vitriol and 6 or 8 parts of water by measure. The operation may be effected in a common glass retort; or in a glass or stone bottle, fitted with a bung having two perforations,—one to admit a flannel tube, which descends to the bottom of the bottle, the other for the exit tube. A very convenient vessel, and one not liable to breakage, is made of tinned copper. It should be furnished with two apertures closed with corks, one of which is perforated to receive a flexible metallic exit tube. One equivalent of zinc decomposes one equivalent of water, and unites with one equivalent of oxygen, forming one equivalent of the oxide of zinc, while an equivalent of hydrogen is evolved from the water. This equivalent of oxide of zinc combines with an equivalent of sulphuric acid, and forms one equivalent of the sulphate of zinc. $Zn + HO + SO^3 = ZnO, SO^3 + H$.

Materials.		Composition.			Products.	
1 eq. Water ..	9	1 eq. Hydrogen	1		1 eq. Hydrogen....	1
		1 eq. Oxygen..	8	1 eq. Oxide Zinc 40·5		
1 eq. Zinc			32·5			
1 eq. Sulphuric Acid			40		1 eq. Sulphate Zinc	80·5
			81·5			81·5

It is remarkable that zinc alone does not decompose water, but sulphuric acid enables it to do so.

As 32·5 parts, by weight, of pure zinc evolve 1 part, by weight, of pure hydrogen, one troy ounce, or 480 grains, should disengage 14·769 grains, or about 690 cubic inches of gas. (One ounce of zinc is found to cause the evolution of 615 cubic inches of hydrogen gas—*Graham.*)

Properties.—Hydrogen is a colourless, tasteless, and, when pure, odourless gas. That obtained by the above process is not quite pure. It usually contains traces of sulphuretted hydrogen and carbonic acid, which may be removed by washing the gas with either lime water or a solution of caustic alkali, and it also has a peculiar odour. When prepared with sulphuric acid, contaminated with arsenious acid, it contains traces of arsenuretted hydrogen. Its sp. gr. is 0·0693 (0·06926—*Graham;* between 0·0691 and 0·0695—*Dumas* and *Boussingault*), so that it is about 14·4 times lighter than atmospheric air. Its refractive power is very high. It is combustible, burning in atmospheric air or oxygen gas with a pale flame, and forming water. It is not a supporter of combustion. It is a constituent of some powerful acids, as the hydrochloric, and of a strong base, ammonia. In its chemical relations it is analogous to the metals.

Characteristics.—Free hydrogen is recognised by its combustibility, the pale colour of its flame, its not supporting combustion, and by its yielding, when exploded with half its volume of oxygen, water only.

The existence of hydrogen in organic substances is ascertained by the production of water when they are burnt in a combustion tube: the hydrogen constitutes one-ninth part, by weight, of the water produced.

Physiological Effects.—*α. On Vegetables.*—Plants which are deprived of green or foliaceous parts, or which possess them in small quantity only, cannot vegetate in hydrogen gas: thus seeds will not germinate in this gas; but vegetables which are abundantly provided with these parts vegetate for an indefinite time in hydrogen.[1] Applied to the roots of plants in the form of gas, it is injurious,[1] but an aqueous solution of it seems to be inert.[2] It has been said that when plants are made to vegetate in the dark, their etiolation is much diminished if hydrogen gas be mixed with the air around them; and in proof of this, Humboldt mentions several plants which retained their green colour though growing in the dark in the Freyberg mines,[3] where the surrounding air contained hydrogen.

---

[1] Saussure, *Recherches Chim. sur la Végét.* pp. 195 and 209.

β. *On Animals generally.*—Injected into the jugular vein of a dog, hydrogen produces immediate death, probably from its mechanical effects in obstructing the circulation and respiration.[4]

γ. *On Man.*—It may be breathed several times without any injurious effects. Scheele made twenty inspirations without inconvenience. Pilatre de Rozier frequently repeated the same experiment; and to show that his lungs contained very little atmospheric air, he applied his mouth to a tube, blew out the gas, and fired it, so that he appeared to breathe flame. If much atmospheric air had been present, detonation must have taken place in his lungs.[5] If we speak while the chest is filled with hydrogen, a remarkable alteration is perceived in the tone of the voice, which becomes softer, shriller, and even squeaking. That this effect is, in part at least, if not wholly, physical, is shown by the fact that wind instruments (as the flute, pitchpipe, and organ) have their tones altered when played with this gas. The conclusion which has been drawn by several experimenters as to the effects of breathing hydrogen, is, that this gas possesses no positively injurious properties, but acts merely by excluding oxygen.

[MM. V. Regnault and J. Reiset,[6] in a valuable memoir on respiration, have detailed experiments showing that animals can live a considerable length of time in an atmosphere in which hydrogen replaces in great part the nitrogen of atmospheric air. The difference they observed under this condition was that of a greater consumption of oxygen,—an effect which MM. Regnault and Reiset attribute to the increased activity of the respiratory function. This increase they consider is brought about as a compensating action for the greater cooling effect produced on the animal by the contact of hydrogen gas.—ED.]

USES.—α. In *pulmonary consumption*, Dr. Beddoes recommended inhalations of a mixture of atmospheric air and hydrogen gas, on the ground that in this disease the system was hyperoxygenised. The inhalation was continued for about fifteen minutes, and repeated several times in the day.[7] Ingenhousz fancied that it had a soothing effect when applied to wounds and ulcers.

β. In *rheumatism* and *paralysis* it has been used by Reuss as a resolvent.

γ. A *flame of hydrogen* has been employed in Italy as a cautery, to stop caries of the teeth.[8]

---

[1] Saussure, *Ibid.* p. 105.
[2] De Candolle, *Physiol. Végét.* t. iii. p. 1360.
[3] Thomson's *Syst. of Chemistry*, vol. iv. p. 347–8, 6th edit.
[4] Nysten, *Recherches*, p. 10.
[5] Beddoes, *New Method of Treating Pulmonary Consumption*, p. 44.
[6] *Annales de Chimie et de Physique*, 3ème sér., tom. xxvi. p. 299.
[7] *Op. supra cit.*
[8] *Dict. Mat. Méd.* par Mérat et De Lens.

AQUA HYDROGENII; *Hydrogen Water.*—This is an aqueous solution of hydrogen prepared by artificial pressure. At the ordinary pressure and temperature of the atmosphere, water dissolves about 1½ per cent. of its bulk (1·61 per cent. *Dr. W. Henry*; 2 per cent. *Dalton*; 4·6 per cent. *Saussure*). The *eau hydrogénée,* formerly prepared at the Tivoli, by strong pressure, contained a third of its volume, or about 33 per cent. of its bulk of hydrogen;[1] and Gmelin[2] states, on the authority of De Marty, that the water gradually acquired the power of taking up more hydrogen (in two years not quite an equal volume), and he suggests that perhaps a *suboxide of hydrogen* H^2O, was formed. Hydrogen water is said to have been successfully employed in the treatment of diabetes.[3]

3. AQUA.—WATER, or the Protoxide of Hydrogen.

Symbol Aq. *Formula* HO. *Equivalent Weight* 9. *Equivalent Volume of Steam* 1 or □

HISTORY.—The ancients regarded water as an elementary substance, and as a constituent of most other bodies. This opinion, apparently supported by numerous facts, was held until the year 1783.

The discovery[4] of the composition of water has been at different times claimed for Watt, for Cavendish, and for Lavoisier. To Watt is certainly due the credit of having made the earliest written statement of the real composition of water on record.

On the 26th of April, 1783, Watt[5] wrote a letter to Dr. Priestley, in which he concludes "that water is composed of dephlogisticated air and phlogiston deprived of part of their latent or elementary heat."

The Hon. Mr. Cavendish,[6] in his paper read to the Royal Society on the 25th of January, 1784, stated that when 423 measures of inflammable air, and 1000 of common air, are mixed and exploded, "almost all the inflammable air, and about one-fifth of the common air, lose their elasticity, and are condensed into the dew which lines the glass."

In the summer of 1783, Dr. (afterwards Sir Charles) Blagden[7] gave some account of Cavendish's experiments, and of his conclusions therefrom, to Lavoisier,[8] who, in June 1782, repeated and verified them.

NATURAL HISTORY.—Water is found in both kingdoms of nature.

a. IN THE INORGANISED KINGDOM.—Water exists in the atmosphere; it forms seas, lakes, and rivers; it is mechanically disseminated among rocks; and, lastly, it constitutes an essential part of some minerals. In the atmosphere it is found in two states; as a vapour (which makes about one-seventieth by volume, or one one-hundredth by weight, of the atmosphere) it is supposed to be the cause of the blue colour of the sky; and in a vesicular form (?) it constitutes the clouds. The average depth of the ocean is calculated at between two or three miles. Now as the average height of dry land above the surface of the sea is less than two miles, it is evident that if the present dry land were distributed over the bottom of the ocean, the surface of the globe would present a mass of waters a mile in depth. Even on the supposition that the mean depth of the sea is not greater than the fourth part of a mile, the solid contents of the ocean would be 32,058,939¾ cubic miles.[1] The quantity of water disseminated through rocks must be, in the aggregate, very considerable, although it is impossible to form any correct estimate of it. Water enters into the composition of many minerals, either as *water of crystallisation*, as *interstitial water*, or combined as a *hydrate*.

---

[1] *Dict. Mat. Méd.* par Mérat et De Lens, art. *Hydrogène.*

[2] *Handbuch der Chemie,* Bd. i. S. 533, Heidelberg, 1843.

[3] Hallé, *Cours de* 1801, quoted in the *Dict. Mat. Méd.*

[4] For full details respecting the discovery of the composition of water, see *Correspondence of the late James Watt on his Discovery of the Theory of the Composition of Water, with a Letter from his Son.* Edited, with introductory remarks and an appendix, by J. P. Muirhead, Esq., F.R.S.E. London, 1846.

[5] *Phil. Trans.* vol. lxxiv. for the year 1784, pp. 330 and 333.

[6] *Ibid.*

[7] Crell's *Chemische Annalen* for 1786.

[8] *Mémoires de l'Académie Royale des Sciences pour l'année* 1781, p. 472. Paris, 1784. [Lavoisier's paper, though published in the Mémoires said to be for 1781, was read to the Académie on the 11th of November, 1783, and was not printed till the year 1784.]

β. IN THE ORGANISED KINGDOM.—Water is an essential constituent of vegetables and animals.

PURIFICATION.—Various methods are resorted to for the purpose of purifying common water: those which require to be noticed are *subsidence*, *filtration*, *ebullition*, *distillation*, and the addition of certain *chemical agents*.

1. *Subsidence.*—By allowing water to remain for some time in perfect repose, various impurities mechanically suspended in it gradually subside; and from these the water is decanted. In this way accumulations of filth are formed in the tanks and cisterns employed for the reception of common river water. This method of purification is sometimes the only one resorted to, and at other times is preliminary to further purifications by the following processes.

2. *Filtration.*—By this process water is rendered clear and transparent. It removes living beings and other suspended impurities, and is also capable of removing certain substances held in solution.[2] The materials employed for the filtration of water are perforated plates of metal or stoneware, unsized or bibulous paper, flannel, cloth, or other tissues, sponge, porous stone (filtering stone), charcoal (animal charcoal is more effective than vegetable charcoal), and beds of sand.

Paper is only fitted for operations on the small scale. Two kinds of filter paper are usually kept,—a coarser and a finer kind; the former for the separation of the grosser particles, the latter for the removal of finely divided matters. In chemical operations it is necessary to exercise great care in the selection of filter paper, in order to avoid the use of those papers which communicate iron, lime, or organic matters to the liquid. The coarse or rough brownish or bluish woollen paper used by pharmaceutists is useful for the rapid filtration of water, and the separation of impurities, but is unfit for collecting precipitates on.[1]

---

[1] *Thomson's System of Chemistry*, 6th edit. vol. iii. p. 195.

[2] By filtration through animal charcoal, water may be deprived of colouring and odorous matters which it held in solution; and by filtration through sand, both Berzelius and Matteucci (*Lectures on the Physical Phenomena of Living Beings*, p. 31, Lond. 1847) state that a saline solution may be more or less completely deprived of salt. Matteucci found that the density of a saline solution was reduced from 1·00 to 0·91 by filtration through a tube of about 26 feet long, filled with sand; but after some time the sand ceased to deprive the solution of its salt.—"It has been supposed by some, that sea-water, when passing up through a considerable stratum of sand, may be deprived of its salt as well as the impurities which visibly foul it. It is certain that in many places remarkably good fresh water is found by digging a few feet in the sand on the sea-shore, at a very short distance from the high-water mark. This is the case at Yarmouth, on the Norfolk coast; and the water procured from these wells is purer than any other that is found about the town: but there is no direct evidence that this is sea-water filtered by ascent through the sand, since it may well be supposed to be fresh water, rising from a great distance within land, that has undergone the last degree of purification by its passage through the fine clear sand of which the soil is composed for a considerable distance off the sea-shore." (Saunders' *Treatise on Mineral Waters*, p. 89, 1800.)

In the stoneware filtering machines usually sold in the shops, a combination of filtering materials (viz. sponge, sand, and charcoal) is generally employed.[2]

Beds of sand are used for the filtration of water on the large scale. The water-filters used in the public works of Lancashire are usually constructed as follows:—"An excavation of about six feet in depth, and of sufficient extent, is lined to a considerable thickness with well-puddled clay, to make it water-tight. Upon the clay floor is laid—first, a stratum of large stones, then a stratum of smaller stones, and finally a bed of coarse sand or gravel. To allow the air to escape from the lower beds, small upright tubes, open at both ends, are inserted in these beds, and rising above the surface of the water. The filtered water enters from the lowest bed, into a large open iron cylinder, the lower part of which is perforated for the purpose."[3]

3. *Ebullition* destroys the vitality of either animals or vegetables, expels air or carbonic acid, and causes the precipitation of carbonate of lime.

4. *Distillation.*—When properly conducted this is the most effectual method of purifying water. But distilled water is in general contaminated by traces of organic matter. (See *Aqua destillata.*)

5. *The addition of chemical agents* to water is another mode which has been proposed and practised for freeing water from some of its impurities.

α. *Alum* is popularly used to clear muddy water. Two or three grains are sufficient for a quart of water. The alum decomposes the bicarbonate of lime: sulphate of lime is formed in solution, and a hydrate of alumina is precipitated in a flocculent form, carrying with it various mechanical impurities. It is obvious that alum adds nothing to the chemical purity of the water, but, by converting the carbonate into sulphate of lime, augments its hardness.

β. *Caustic alkalies* added to water holding in solution bicarbonate of lime, saturate the excess of carbonic acid, and throw down carbonate of lime, leaving an alkaline carbonate in solution.

γ. *Alkaline carbonates* soften water, decompose all the earthy salts (calcareous and magnesian sulphates, chlorides, and bicarbonates), and precipitate the earthy matters. They leave, however, in solution an alkaline salt, but which does not communicate to water the property of hardness.

δ. *Lime.*—A patent has recently been taken out by Professor Clark,[4] of Aberdeen, for the purification of waters. The patent process consists in the addition of lime to water. The lime decomposes the supercarbonate of lime held in solution, saturates the excess of carbonic acid, and forms carbonate of lime, which is precipitated. The effect of this process is similar to that of ebullition. It has no effect on the earthy sulphates and chlorides.

---

[1] For an account of the relative fitness of different kinds of paper for use as filter papers, see Griffin's *Chemical Recreations*, 8th ed. p. 75, Lond. 1838.

[2] In Webster's *Encyclopædia of Domestic Economy*, pp. 530–3, will be found descriptions and figures of various filter-machines.

[3] Graham's *Elements of Chemistry*, 2d ed. p. 317.

[4] See *Repertory of Patent Inventions* for October 1841; also, *A new Process for Purifying the Waters supplied to the Metropolis by the existing Water Companies; rendering each water much softer, preventing a fur on boiling, separating vegetating and colouring matter, destroying numerous water-insects, and withdrawing from solution large quantities of solid matter not separable by mere filtration*, by T. Clark, Professor of Chemistry in the University of Aberdeen, 2d edit. Lond. 1841.

ε. In India the seeds of *Strychnos potatorum*, called *clearing nuts*, are used for clearing muddy water. They are sold for this purpose in the ripe and dried state in the bazaars. "The natives never drink clear well-water if they can get pond or river-water, which is always more or less impure, according to circumstances. One of the seeds is well rubbed for a minute or two round the inside of the vessel containing the water, generally an unglazed earthen one, which is then left to settle; in a very short time the impurities fall to the bottom, leaving the water clear, and, so far as I have been able to learn, perfectly wholesome. These seeds are constantly carried about by the more provident part of our officers and soldiers in time of war, to enable them to purify their water. They are easier to be obtained than alum."[1] The nature of the action of these seeds on the water has not been ascertained: Dr. O'Shaughnessy[2] suggests that it depends on astringency.

PROPERTIES.—Pure water has the following properties:—at ordinary temperatures it is a transparent liquid, usually described as being both odourless and colourless; but it is well known that the camel can scent water at a considerable distance, so that to this animal it is odorous; and as regards its colour, we know that all large masses of water have a bluish-green colour,[3] though this is usually ascribed to the presence of foreign matters. When submitted to a compressing force equal to 30,000 lbs. on the square inch, 14 volumes of this liquid are condensed into 13 volumes, so that it is elastic. A cubic inch of water at 62° F., Bar. 30 inches, weighs 252·458 grains, so that this fluid is about 815 times heavier than atmospheric air; but being the standard to which the gravities of solids and liquids are referred, its specific weight is usually said to be 1·. An imperial pint weighs, at 62°, 8,750 grs. (=20 oz. Avoirdupois; or 1 lb. 6 oz. 1 drachm 2½ scruples Apothecaries' weight). Water has the greatest density at 39°·2 Fahr. At a temperature of 32° it crystallizes, and in so doing expands. The sp. gr. of ice is 0·916. The fundamental form of crystallised water (ice) is the rhombohedron. Water evaporates at all temperatures, but when the barometer stands at 30 inches, water boils at 212°, and is converted into steam, whose bulk is about 1700 times that of water, and whose sp. gr. is 0·622 (that of hydrogen being 1).

In its chemical relations water may be regarded as a neutral body. It reacts neither as an acid nor as an alkaline or basic body. It combines with acids, alkalies, and many salts. When deprived of water, the oxygen acids no longer present the qualities which characterise acids. Thus anhydrous sulphuric acid does not redden litmus, and exhibits a disposition to unite with salts rather than with bases. Water rapidly absorbs some gases, as fluoride of boron, ammonia, &c. It is neither combustible nor a supporter of combustion.

Characteristics.—Water is recognised by being volatile, incombustible, incapable of supporting combustion, miscible with alcohol in all proportions, with ether in certain proportions, and not miscible with the fixed oils. When pure it is odourless, tasteless, and possesses neither acid nor alkaline qualities. It is greedily absorbed by fused chloride of calcium, which has great affinity for it, and is, therefore, employed for drying gases and absorbing moisture.

---

[1] Roxburgh's *Flora Indica*, vol. i. p. 576, Serampore, 1832.

[2] *The Bengal Dispensatory*, Lond. 1842.

[3] For some remarks on the colour of the ocean, see Jameson's *Journal*, vol. xxv.

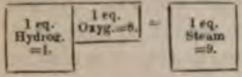
Potassium thrown on it in the open air takes fire. By the galvanic battery it is decomposed into two measures of hydrogen and one of oxygen gas.

Anhydrous sulphuric acid and fluoride of boron produce dense white fumes in an atmosphere containing aqueous vapour. Hydrochloric acid and some other gases also produce white fumes when brought in contact with aqueous vapour.

The quantity of water contained in solid bodies is frequently determined by drying them, and ascertaining the loss which they in consequence suffer. Desiccation may be effected by heat, either alone or aided by a current of artificially dried air; or by a vacuum, either alone or aided by the presence of oil of vitriol (*Leslie's method of drying*). In some cases these methods fail to expel the whole of the water, which can only be got rid of by the substitution of another substance for it.

In organic analysis, the quantity of water produced is determined by passing the volatile products of combustion over chloride of calcium contained in a tube, ascertaining the increase of weight which this salt thereby gains.

COMPOSITION.—The composition of water is determined both by analysis and synthesis. If this liquid be submitted to the influence of a galvanic battery, it is decomposed into two gases; namely, one volume of oxygen and two volumes of hydrogen. These gases, in the proportions just mentioned, may be made to re-combine, and form water, by heat, electricity, or spongy platinum.



	Atoms.	Eq. Wt.	Per Cent.	Berz. & Dulong.
Hydrogen	1	1	$11{\cdot}1\dot{1}$	11·1
Oxygen	1	8	$88{\cdot}8\dot{8}$	88·8
Water	1	9	100·00	100·0

	Vol.	Sp. Gr.
Hydrogen gas	1	0·0692
Oxygen gas	0·5	0·5528
Aqueous vapour	1	0.6220

TESTS OF THE PURITY OF WATER.—See *Aqua destillata.*

PHYSIOLOGICAL EFFECTS.—Water is an essential part of the blood and of all living tissues. It is from this liquid that the tissues derive their properties of extensibility and flexibility. It gives fluidity to the blood, and enables the transportation of organic particles from one part of the body to another to be effected. Lastly, it contributes to most of the transformations which occur within the body.

Considered dietetically, aqueous drinks serve several important purposes in the animal economy: they repair the loss of the watery part of the blood, caused by evaporation and the action of the secreting and exhaling organs, and they act as solvents of various alimentary substances, and thereby assist the stomach in the act of digestion. If, however, they are swallowed in excessive quantity, they may impede digestion by diluting the gastric juice. It is not improbable that water acts as a real nutritive agent; that is, assists in the formation of the solid parts of the body.

As an agent for the communication or abstraction of heat to or from the body, water has been before noticed (see *ante*, p. 17 et seq.)[1] Furthermore, the influence of atmospheric humidity in modifying the character of climates has likewise been briefly referred to (see *ante*, p. 71).

---

[1] Dr. James Arnott has lately recommended that parts should be frozen in order to produce anæsthesia before performing surgical operations.—*Lancet*, July 22 and Sept. 9, 1848; *Med. Gaz.* Dec. 1, 1848.

Water moderately warm, and which neither cools nor heats the body, acts locally as an emollient, softening and relaxing the various tissues to which it is applied (see *Emollients*, p. 170). When swallowed it allays thirst, becomes absorbed, mixes with, and thereby attenuates, the blood (see *Diluents*, p. 172), and promotes exhalation and secretion, especially of the watery fluids. Administered in large quantities it excites vomiting. The continued excessive use of water has an enfeebling effect on the system, both by the relaxing influence on the alimentary canal, and by the excessive secretion which it gives rise to.

Injected into the veins in moderate quantities, tepid water has no injurious effects; it quickens the pulse and respiration, and increases secretion and exhalation. Large quantities check absorption (see *ante*, p. 107), and cause difficulty of breathing and an apoplectic condition. Thrown with force into the carotid artery, it kills by its mechanical effect on the brain.

USES.—Besides the dietetical and thermotic purposes for which water is employed in medicine, it serves as a diluent, humectant, emollient, evacuant, and, in pharmacy, as a solvent.

Water or bland aqueous liquids are employed in some cases of poisoning. They serve to dilute the acrid and irritant poisons, the intensity of whose action on the stomach they lower. Moreover, the presence of aqueous fluids favours the expulsion of substances by vomiting (see *Antidotes*, pp. 158 and 163).

In preternatural dryness and rigidity of parts (*e. g.* of mucous surfaces, the skin, wounds, and ulcers), water and mild aqueous liquids are useful moisteners and emollients.

The copious use of water augments the quantity of liquid thrown out of the system by the cutaneous and pulmonic surfaces, and by the kidneys (see *ante*, pp. 240, 249, and 254). If our object be to promote diaphoresis, external warmth should be conjoined with the internal use of diluents; whereas, when we wish to excite the renal vessels, the skin should be kept cool. In inflammatory affections of the urinary passages, we advise the free employment of aqueous fluids, with the view of diluting the urine, and thereby of rendering it less acrid and irritating.

The subject of *hydropathy* has been already briefly alluded to (see *ante*, p. 34.)

What is called *water-dressing* may be regarded as a modified and improved form of poultice. It consists in the application of two or three layers of soft lint dipped in water and applied to inflamed parts, wounds, and ulcers, the whole being covered with oiled silk or Indian rubber, which should project beyond the margin of the lint, to retain the moisture and prevent evaporation. Dr. Macartney[1] considers it to operate differently to a poultice: unlike the latter, he says it prevents or diminishes the secretion of pus, checks the formation of exuberant granulations, and removes all pain. Moreover, the water is not apt to become sour, like a poultice, and does not injure the sound part.[2]

Water is frequently employed in pharmacy for extracting the active principles of various medicinal agents. The solutions thus procured are termed by the French reformers[1] of pharmaceutical nomenclature, *hydroliques*, or *hydrolica* (from ὕδωρ, *water*). Those prepared by solution or mixture are termed *hydrolés*, and are divided by Cottereau[2] into three classes;—mineral (as lime-water), vegetable (as almond emulsions, mucilage, infusions, decoctions, &c.), and animal (as broths). Those obtained by distillation are denominated *hydrolats*.

---

[1] *Treatise on Inflammation*, p. 180, London, 1838.

[2] For further details respecting the water-dressing, see, besides the work already quoted, *Mém. de l'Académie Royale de Médecine*, Fasc. 1, 1836.—*Lancet*, vol. ii. for 1834–5, pp. 121, 277, and 484; and vol. i. for 1835–6, p. 450.

1. AQUA DESTILLATA; *Aqua Distillata; Distilled Water.*—Obtained by distilling common water in a proper still. The first twentieth (fortieth, *Ph. L.*) part should be rejected: the last portions ought not to be distilled. The first distilled portion is to be rejected, as it may contain carbonic acid, ammonia, and other volatile impurities. The latter portions are not to be distilled, to guard against empyreuma from the charring of organic matters. The still in which the operation is conducted ought not to be employed for any other purpose, otherwise the water is apt to receive a faint smell, and taste of the last matters subjected to distillation. "A copper still should be used provided with a copper or block tin worm, which is not used for the distillation of spirits, as traces of alcohol remaining in the worm and becoming acetic acid cause the formation of acetate of copper, which would be washed out and contaminate the distilled water. The use of white lead cement about the joinings of the worm is also to be avoided, as the oxide of lead is readily dissolved by distilled water" (Graham). Distilled water remains unchanged on the addition of any of the following tests:—Solutions of the caustic alkalies, lime, oxalic acid, the barytic salts, acetate of lead, nitrate of silver, and soap. If turbidness, milkiness, or precipitate, be occasioned by any of these, we may infer the existence of some impurity in the water. But water which has been repeatedly distilled gives traces of acid and alkali when examined by the agency of voltaic electricity, which, therefore, is the most delicate test of the purity of water. Distilled water also usually contains traces of organic matter. Nitrate of silver is the most sensible test of its presence:[3] a solution of this salt in pure water, preserved in a well-stoppered bottle, undergoes no change of colour by exposure to light; but if any vegetable or animal matter be present, the metal is partially reduced, and the liquid acquires a dark or reddish tint.

Owing to its freedom from air and carbonic acid, distilled water is flat, mawkish, and by no means agreeable to the taste.[4] Its dietetical employment as a substitute for common water was suggested by Dr. Heberden,[5] and warmly advocated and practised by Dr. Lambe,[6] on theoretical rather than practical grounds. Its use has also been recommended in some forms of lithiasis (especially in the oxalate of lime diathesis). At the present time, however, distilled water is almost exclusively employed for chemical and pharmaceutical purposes.

---

[1] *Pharmaceutical Nomenclature* of MM. Chereau and Henry, in Duncan's *Supplement to the Edinburgh New Dispensatory*, p. 152.

[2] *Traité Elémentaire de Pharmacologie*, Paris, 1835.

[3] Dr. Davy, in Jameson's *Edinburgh New Philosophical Journal*, Dec. 1828, p. 129.

[4] [This, though true of water freshly distilled, or kept hermetically sealed, will not apply to ordinary distilled water. Air and oxygen are rapidly absorbed, as may generally be shown, after about an hour's exposure, on the addition of the white protoferrocyanide of iron, which immediately changes to blue, indicating the presence of oxygen.—ED.]

[5] *Remarks on the Pump Water of London*, in the *Medical Transactions published by the College of Physicians in London*, vol. i.

[6] *Reports of the Effects of a peculiar Regimen on Scirrhous Tumours and Cancerous Ulcers*, 1809; *Additional Reports on the Effects of a peculiar Regimen*, 1815.

2. AQUÆ MEDICATÆ; *Medicated Waters; Aquæ Destillatæ; Aquæ Distillatæ; Distilled Waters; Hydrolata,* or *Hydrolats.*—Obtained by submitting either fresh, salted, or dried vegetables, or their essential oils, to distillation with water; or by diffusing the essential oils through water. The vegetables employed in the preparation of the distilled water are either immersed in the water or merely exposed to the action of steam.

The medicated waters prepared by distillation from recent vegetables have a finer flavour than those obtained by the diffusion of the oil; but the latter are purer and more permanent. Rose and elder waters are prepared either from the fresh or pickled (salted) flowers. In the preparation of these waters, whether from the vegetables or from the volatile oils, it has been usual to add, either before or after distillation, a portion of spirit of wine, to preserve them from becoming mucilaginous and sour. But according to Mr. Warington's experiments,[1] the practice is injurious, since the spirit becomes gradually converted into acetic acid, and thus renders the waters distinctly acid.

The usual method of preparing these waters is by diffusing the oils through water by the aid of sugar or magnesia; and in the London Pharmacopœia for 1836 they were ordered to be thus extemporaneously prepared. The magnesia effected the minute division, and thereby promoted the solution of the oil in the water. Prepared in this way the medicated waters usually contain a minute portion of magnesia in solution, and, by exposure to the air, let fall flocculi of the carbonate. The magnesia unfits them for the preparation of solutions of some of the metallic salts (*e. g.* bichloride of mercury and nitrate of silver), and in the present Pharmacopœia (1851), the waters are prepared either from the fresh herbs, seeds, &c. or from their oils. When the oils are used they are now ordered to be mixed with silica in fine powder, instead of with magnesia, the proportions being 2 drachms of oil to a gallon of distilled water, and 2 drachms of powdered silica. The directions are—

> "Beat up the oil carefully first with the silica and afterwards with the water, and strain the liquor."

When the fresh materials are used the liquor is distilled.

The mucilaginous flocculi which form in the distilled waters are microscopic algaceous plants.[2]

3. INFUSA; *Infusions.*—These are aqueous solutions of vegetable substances obtained without the aid of ebullition. They are usually prepared by digesting soft water (cold or hot, according to circumstances) on the substance sliced, bruised, or reduced to coarse powder, in a glazed earthenware or porcelain vessel fitted with a cover. Polished metal vessels retain the heat better, but are objectionable on account of their ready corrosion. Hard water is a less perfect solvent of organic matter than soft water, and, moreover, it becomes turbid (from the deposition of chalk) by keeping: hence it should not be employed in the preparation of infusions. Cold water is used when the active principle is very volatile, or when it is desirable to avoid the solution of any substance soluble in hot water. Thus when the object is to extract the bitter principle from calumba or Iceland moss without taking up the starchy matter, cold water is preferred. In general, however, boiling water is used. Infusions are preferred to decoctions when the active principle is either volatilisable by a boiling heat, as in the case of essential oil, or readily undergoes some chemical change by ebullition, as in the case of senna.

---

[1] *Pharmaceutical Journal,* vol. iv. p. 558.

[2] See a paper by the author, in the *Pharmaceutical Journal,* vol. vii. p. 337.

Infusions may also be prepared by percolation or displacement. The advantage of this process (which will be more fully noticed hereafter under the head of *Tincturæ*) is, that substances, especially starch and some allied principles, which do not add to the medicinal efficacy of the preparation though they render it more apt to decompose or become mouldy, are not taken up. Infusions prepared by percolation being thus less liable to decay, may be made in larger quantity, and are therefore more economical and convenient.

To preserve vegetable infusions Mr. Alsop[1] recommends that they should be poured while hot into bottles which are to be made perfectly full and to be closed with accurately ground stoppers or with perforated corks, closing immediately the aperture from which the displaced fluid escapes by sealing wax. Dr. Christison[2] suggests that the infusions prepared by percolation would keep better if they were heated to 212° in well-corked bottles by immersing them in boiling water and afterwards separating the coagulated albumen by filtration.

4. DECOCTA; *Decoctions.*—These are prepared by boiling organic substances in water. They should be strained while hot; since, in some cases (*e. g.*, that of cinchona), the liquid becomes turbid on cooling.

DECOCTO-INFUSA. *Decocto-infusions.*—These are decoctions to which, after they have ceased to boil, but while they are still hot, other substances are added, and allowed to digest therein.[3]

By ebullition in water the volatile constituents of vegetables are dissipated; and hence, when these are the active principles, the process is an objectionable one. It is obvious that the saffron in *decoctum aloës compositum*, the sassafras in the *decoctum sarzæ compositum*, and the juniper fruit in the *decoctum scoparii compositum*, are deprived of their volatile oils by boiling, and, therefore, these preparations are on that account objectionable.

DIVISION OF NATURAL WATERS.

Natural waters may be divided into *terrestrial* and *atmospheric*: the former division includes spring, well, river, lake, marsh, mineral, and sea waters; the latter comprehends rain and dew, ice and snow. But for our present purpose they may most conveniently be arranged in three classes;[4] viz. *common waters*, *sea waters*, and *mineral waters*.

1. *Aquæ Communes.—Common Waters.*

Under this head are comprehended those waters which are used for drink, for dressing food, or for other purposes of domestic economy. It includes the waters commonly known as *rain, spring, river, well, pump, lake,* and *marsh waters.*

---

[1] *Pharmaceutical Journal*, vol. i. p. 57.

[2] *Dispensatory*, 2d edit. p. 14.

[3] *Pharmaceutical Journal*, vol. vii. p. 353.

[4] See Dr. Thomson's *System of Chemistry*, vol. iii. p. 191, 6th edit. Lond. 1820.

Before proceeding to notice these several varieties of water it will be useful to consider the comparative properties of the pure natural waters, of hard waters, and of natural waters impregnated with organic matters.

Pure natural waters.—Besides rain water, some spring, well, and river waters are remarkable for their purity. The water of the Malvern springs is remarkable for its extreme purity. According to Sir Charles Scudamore's analysis,[1] this water contains only about a third part of the solid matter found by Mr. R. Phillips in Thames water taken at Chelsea. These waters are beneficial in lithiasis, chiefly on account of their purity. The well water of Ascot Heath is also remarkably pure. According to Mr. Squire,[2] it contains only one-fifth of the lime found in Thames water. In Scotland, springs containing only between an 8,000th and 12,000th of saline constituents are common.[3]

Though the purest waters are the most wholesome, yet very pure water is possessed of one very dangerous quality, viz. that of rapidly corroding lead, and thereby acquiring an impregnation of this metal. Distilled water has no action on lead, provided the air be excluded; but when this is admitted, a thin white crust[4] of carbonate and hydrate of the oxide of lead is speedily formed. Now it is very remarkable that the neutral salts usually found in spring water impair the corrosive action of water and air, and thus exercise a protecting influence. To the presence of saline matter, therefore, is to be ascribed the comparative infrequency of the plumbeous impregnation of water kept in leaden cisterns or transmitted through leaden pipes. All salts do not possess an equally protective influence, the carbonates and sulphates being most, the chlorides the least energetic of those saline substances commonly met with in spring waters. Rain and other pure kinds of water which contain but minute portions of those protecting salts readily acquire an impregnation of lead from roofs, gutters, cisterns, or pipes, made of this metal.[5] "There is another way in which lead is occasionally acted upon by water, and to which attention was first directed by Dr. Paris: it is in consequence of galvanic action, and in cases where iron and lead are in metallic contact, as often happens in the employment of iron bars to strengthen and support leaden cisterns, and in the introduction of iron pumps under similar circumstances: in these cases, though the lead is rendered electro-negative, and so far protected from acid reaction, it becomes more susceptible of, and exposed to, the agency of electro-positive elements, among which are alkalies and alkaline earths, and these exert considerable solvent power over it. So that all such combinations of lead and iron, zinc, &c. should be cautiously avoided. Lastly, there is another source of contamination of water by lead, which is this:—leaden cisterns have often leaden covers, and the water, spontaneously evaporating from the cistern, is condensed (now in the form of *pure* or *distilled* water) upon the lid, upon which it exerts its usual energetic action, and drops back into the body of the cistern, contaminated by lead: so that wood not leaded should be used in all cases for covering leaden reservoirs."[1]

---

[1] *Chemical and Medical Report of the Properties of the Mineral Water of Buxton, &c. &c.* 1820.

[2] *Pharmaceutical Journal*, vol. iv. p. 9.

[3] *Christison's Dispensatory*, 2d edit.

[4] Dr. Christison (*Transactions of the Royal Society of Edinburgh*, vol. xv. part ii. 1842) made three analyses of this crust, and found that it consisted of oxide of lead, carbonic acid, and water, in proportions which nearly correspond to the formula $3\,PbO + 2\,CO^2 + Aq.$; that is, a compound of three equivalents of oxide of lead, two of carbonic acid, and one of water; or rather, a compound of two equivalents of carbonate of lead in union with one equivalent of hydrated oxide of lead $= 2\,(PbO + CO^2) + (PbO + Aq.)$

[5] I have been informed that the presence of mortar in a cistern promoted the corrosion of the lead by the water. [A case came under the notice of one of the Editors, in which the corrosion of lead was distinctly traced to the presence of pieces of mortar in a cistern. The metal was found perforated in several places, and pieces of mortar were discovered at the bottom of each perforation.]

[A dreadful instance of the evil arising from poisoning by lead in water occurred at Claremont, where the ex-Royal Family of France were the sufferers.[2] The water was extremely pure, and contained only 5·7 grains of solid matter in the gallon, the salts (sulphates especially) not being present in sufficient quantity to protect the water from contamination.—ED.]

Water impregnated with lead in the way above alluded to possesses the following properties:—By exposure to the air it becomes covered with a thin white film, and the vessel in which it is contained becomes lined with a thin white incrustation of a pearly lustre. This crust dissolved in acetic acid yields a solution which is rendered blackish-brown by sulphuretted hydrogen, and yellow by either iodide of potassium or bichromate of potash.

[By far the most delicate test consists in adding nitric acid to the suspected water, gently evaporating it, and then passing sulphuretted hydrogen through it, when if lead be present the brownish hue appears.—ED.]

The continued use of water containing lead gives rise to *lead* or *painter's colic* (see *ante*, p. 191). If the cause of the malady be not discovered, and the water not discontinued, *palsy* usually succeeds colic (see *ante*, p. 192).

The following conclusions, drawn by Dr. Christison,[3] as to the employment of lead pipes for conducting water, are of considerable importance, and therefore deserve especial attention.

"1. Lead pipes ought not to be used for the purpose, at least where the distance is considerable, without a careful examination of the water to be transmitted.

"2. The risk of a dangerous impregnation with lead is greatest in the instance of the purest waters.

"3. Water which tarnishes polished lead when left at rest upon it in a glass vessel for a few hours, cannot be safely transmitted through lead-pipes without certain precautions.[4]

"4. Water which contains less than about an 8000th of salts in solution cannot be safely conducted in lead-pipes without certain precautions.

"5. Even this proportion will prove insufficient to prevent corrosion, unless a considerable part of the saline matter consist of carbonates and sulphates, especially the former.

"6. So large a proportion as a 4000th, probably even a considerably larger proportion, will be insufficient, if the salts in solution be in a great measure chlorides.

---

[1] Brande's *Dictionary of Materia Medica and Practical Pharmacy*, p. 80, Lond. 1839.

[2] Vide Dr. Gueneau de Mussy's *Report*, *Dublin Journal*, vol. vii. p. 405.

[3] *Trans. of the Royal Society of Edinburgh*, vol. xv. part ii. p. 271.

[4] "Conversely, it is probable, though not yet proved, that if polished lead remain untarnished, or nearly so, for twenty-four hours in a glass of water, the water may be safely conducted through lead pipes."

"7. It is, I conceive, right to add, that in all cases, even though the composition of the water seems to bring it within the conditions of safety now stated, an attentive examination should be made of the water after it has been running for a few days through the pipes. For it is not improbable that other circumstances, besides those hitherto ascertained, may regulate the preventive influence of the neutral salts."

Hard Water.—Common water which decomposes and curdles soap is denominated ***hard water***, to distinguish it from those waters which are readily miscible with soap, and which are termed ***soft waters***. Spring and well waters are frequently hard, while rain water and usually river water are soft. The hardness of water depends on earthy salts, the most common of which is sulphate of lime. By the mutual action of this salt and soap, double decomposition is effected: the sulphuric acid unites with the alkali of the soap, while the fatty acids unite with the lime to form an insoluble earthy soap. On this is founded the use of a ***tincture of soap*** as a ***soap test*** of the hardness of water. This tincture is made by dissolving one drachm of curd soap in an imperial pint of proof spirit.[1]

According to Dr. Christison, water which contains more than $\frac{1}{2000}$th of saline matter is scarcely fit for domestic use; that which contains $\frac{1}{4000}$th or upwards is called hard; that which contains not above $\frac{1}{5000}$th part lathers with soap, may be used for washing, and is, therefore, called soft; that which does not contain more than $\frac{1}{6000}$th part may be used in pharmacy according to the Edinburgh Pharmacopœia. But this statement requires some modification; the hardness of the water depending more on the nature than on the quantity of the solid constituents. Thames water, a remarkably soft water, contains, according to Mr. R. Phillips, from $\frac{1}{3608}$th to $\frac{1}{3763}$d of solid matter in solution. The deep well-water of the London basin yields, according to Professor Graham, $\frac{1}{1240}$th part of solid matter, though, as it contains carbonate of soda and no sulphate of lime, and but little other earthy salts, it is a soft and alkaline water.

Hard water[2] is a less perfect solvent of organic matter than soft water; hence, in the preparation of infusions and decoctions, and for many economical purposes, as for tea-making and brewing, it is inferior to soft water; and, for the same reason, it is improper as a drink in dyspeptic affections. Moreover, it proves injurious in urinary deposits. The unfavourable effects of hard waters on the animal system are especially manifested in horses. "Hard water, drawn fresh from the well," observes Mr. Youatt,[3] "will assuredly make the coat of a horse unaccustomed to it stare, and it will not unfrequently gripe and otherwise injure him. Instinct or experience has made even the horse himself conscious of this; for he will never drink hard water if he has access to soft; he will leave the most transparent and pure [?] water of the well for a river, although the water may be turbid, and even for the muddiest pool."[1]

---

[1] For the mode of using this test, see the *Repertory of Patent Inventions* for October 1841; and *Pharmaceutical Journal*, vol. vi. p. 526.

[2] Sulphate of lime or gypsum is the ordinary constituent of hard waters. Dioscorides (lib. v. cap. 134) describes it as possessing an astringent property, and, when drank, destroying life; and Pliny (lib. xxxvi. cap. 59) states, that C. Proculeius killed himself by taking it. From the few observations respecting it which have been published (see Wibmer, *Die Wirkung der Arzneimittel und Gifte*, vol. ii. p. 11), it appears that it acts on the system as an astringent, causing constipation and disordered digestion. Parent du Chatelet (quoted by Mr. Chadwick) ascribes to it a purgative quality; and refers the chronic diarrhœa, so often observed in the hospital of Salpêtrière and the prison of St.-Lazarus, to the "very great proportion of sulphate of lime and other purgative salts" contained in the water with which both these establishments are supplied.

[3] *The Horse*, p. 359, Lond. 1831.

Water containing organic matter in solution or suspension.— Decomposing organic matter in suspension or solution is found in every river water in a greater or less proportion. Ordinarily the quantity is insufficient to act injuriously; but it cannot be doubted that water strongly contaminated with it must be deleterious. Where, however, the quantity present is insufficient to produce any immediately obvious effects, it is by no means easy to procure decisive evidence of its influence on the system. In those cases in which its operation has been equivocally recognised, it has manifested itself by the production of dysentery.[2] Its influence in a milder form is attended with slight relaxation of bowels. "The beneficial effects derived from care as to the qualities of water," says Mr. Chadwick,[3] "is now proved in the navy, where fatal dysentery formerly prevailed to an immense extent, in consequence of the impure and putrid state of the supplies; and care is now generally exercised on the subject by the medical officers of the army."

The decomposing organic matter above referred to consists principally of the exuviæ of animal and vegetable substances.[4] The water of some of the wells of the metropolis are occasionally contaminated with the odour and flavour of gas-tar. I have myself found this to be the case in a well water obtained near the London Hospital.

---

[1] Some trainers have so much fear of hard or strange water, that they carry with them to the different courses the water that the animal has been accustomed to drink, and that they know agrees with it."

[2] At the Nottingham Assizes, in July 1836, it was proved at a trial (Jackson *versus* Hall), on which I was a witness, that dysentery, in an aggravated form, was caused in cattle by the use of water contaminated with putrescent vegetable matter, produced by the refuse of a starch manufactory. The fish (perch, gudgeon, pike, roach, and dace) and frogs in the pond, through which the brook ran, were destroyed. All the animals (cows, calves, and horses) which drank of this water became seriously ill; and in eight years the plaintiff lost twenty-four cows and nine calves, all of a disease (dysentery) accompanied by nearly the same symptoms. It was also shown that the animals sometimes refused to drink the water; that the mortality was in proportion to the quantity of starch made at different times; and that, subsequently, when the putrescent matter was not allowed to pass into the brook, but was conveyed to a river at some distance, the fish and frogs began to return, and the mortality ceased among the cattle. The symptoms of illness in the cows were as follows: the animals at first got thin, had a rough staring coat, and gave less milk (from two to three quarts less every day); they then became purged, passed blood with the fæces, and at length died emaciated and exhausted. On a post-mortem examination, the intestinal canal, throughout its whole length, was found inflamed and ulcerated. The water, which I examined, was loaded with putrescent matter, and contained chloride of calcium (derived from the chloride of lime employed in bleaching the starch). Traces of free sulphuric acid were occasionally found by one witness.

"Dr. M. Barry affirms that the troops were frequently liable to dysentery while they occupied the old barracks at Cork; but he has heard that it has been of rare occurrence in the new barracks. Several years ago, when the disease raged violently in the old barracks (now the depôt for convicts), the care of the sick was, in the absence of the regimental surgeon, entrusted to the late Mr. Bell, surgeon, in Cork. At the period in question, the troops were supplied with water from the river Lee, which, in passing through the city, is rendered unfit for drinking by the influx of the contents of the sewers from the houses, and likewise is brackish from the tide, which ascends into their channels. Mr. Bell, suspecting that the water might have caused the dysentery, upon assuming the care of the sick, had a number of water-carts engaged to bring water for the troops from a spring called the Lady's Well, at the same time that they were no longer permitted to drink the water from the river. From this simple, but judicious arrangement, the dysentery very shortly disappeared among the troops." (Dr. Cheyne, *On Dysentery, in the Dublin Hospital Reports*, vol. iii. p. 11).

[3] *Report to Her Majesty's Principal Secretary of State for the Home Department, from the Poor Law Commissioners, on an Inquiry into the Sanatory Condition of the Labouring Population of Great Britain*, p. 78, 1842.

[4] "In addition to its saline or natural impurities, the well water of London is sometimes contaminated

The quantity of organic matter contained in common water has not been accurately determined. Dr. Lambe[1] states that from 30 gallons of Thames water, collected at London, he procured 28 grains of a carbonaceous substance. But from Thames water taken out of the river at Windsor, the quantity was considerably less. From six gallons of water he did not procure one grain of this charcoally matter.

Thames water, when taken to sea in casks, soon becomes putrid and offensive, and evolves inflammable vapour.[2] This is owing to the presence of decomposing organic matter. If, however, the water in this fetid state be racked off into larger vessels, and exposed to the air, a slimy deposit is formed, and the water becomes clear, sweet, and palatable. The cleansing which this and other river waters undergo, by which they are deprived of organic matters, seems to depend on the oxidation of the vegetable and animal remains, partly by the oxygen of the air, partly by the deoxidation of the alkaline and earthy salts, as the sulphates.

I have already had occasion to refer to the evolution of sulphuretted hydrogen gas from waters containing both sulphates and decomposing organic matters (see *ante*, p. 72).

Living beings (animals and vegetables), constitute another class of impurities of river water. But the public has formed a very erroneous notion of the extent and nature of this source of impurity, in consequence of the public exhibition in London of aquatic animals by means of the solar and oxyhydrogen microscopes. The animals used on these occasions are collected in stagnant pools in the neighbourhood of the metropolis, and are not found

---

by organic matters, the source of which, especially in the pump-water of churchyards, is sufficiently obvious; and such is usually the place selected for the parish pump. This disgusting source of water should be avoided; and the disgraceful system of burying the dead in the streets of the metropolis should be authoritatively discontinued. Of this nuisance abundant instances occur to every one who walks about London; the churchyard of St. Clement's, in the Strand, is a fair specimen, and there are many infinitely worse. In these the same graves are repeatedly opened, and the coffins thrust in one upon another, according to the most inexplicable system; and it is beneath this superstratum that the waters of the adjacent wells flow, in some instances, perhaps, deep enough to avoid direct contamination, but never free from the suspicion of the oozings of the vicinity." (Brande's *Dictionary of Materia Medica and Practical Pharmacy*, p. 81, 1839.) In the *Report on the Health of Towns (Effect of Interment of Bodies)*, dated 14th June, 1842 (327), it is stated that this pump has been obliged to be shut up, as the water was found unfit for use. In the same work, Dr. Copland, in his evidence before the Committee of the House of Commons, states that water which percolates through soil abounding in animal matter becomes injurious to the health of the individuals using it. This fact, he says, "has been proved on many occasions, and especially in warm climates; and several very remarkable facts illustrative of it occurred in the Peninsular Campaign. It was found, for instance, at Cindad Rodrigo, where, as Sir James M'Grigor states in his account of the health of the army, there were 20,000 dead bodies put into the ground within the space of two or three months, that this circumstance appeared to influence the health of the troops, inasmuch as for some months afterwards all those exposed to the emanations from the soil, as well as obliged to drink the water from the sunk wells, were affected by malignant and low fevers, and by dysenteries, or fevers frequently putting on a dysenteric character. The digestive operations are affected by water abounding with putrid animal matter; so that burying in large towns affects the health of individuals—in the first place, by emanations into the atmosphere, and in the second place, by poisoning the water percolating through that soil."

[1] *An Investigation of the Properties of the Thames Water*, Lond. 1828.

[2] A similar change is reported to have occurred to water collected at St. Jago (see *Phil. Trans* No. 268, p. 788, vol. xxii. 1701).

in the filtered water usually supplied for domestic use. They are found occasionally in the sediment and in the *scum*.

Recent microscopic investigations have shown that animals are liable to both vegetable and animal parasites.[1] Thus goldfish (*Cyprinus auratus*) often become covered with a white efflorescence, and, in consequence, languish and die. When examined by a microscope, this efflorescence is found to be a confervoid plant, and to consist of articulated, cellular tubes, some of which are filled with granules, and one or two nuclei. A similar growth sometimes occurs on efts (*Triton cristata*), by which the tails of these animals are gradually destroyed. Now it is by no means improbable that disease may be induced in a somewhat similar way in the human subject by the use of water containing the shreds or filaments of cryptogamic plants. This suspicion is strengthened by the case related by Dr. A. Farre[2] of a woman who passed by the bowels substances having the ordinary appearance of shreds of false membrane, but consisting entirely of confervoid filaments, properly belonging to the genus *Oscillatoria*. The patient drank the ordinary water which supplies London, and it is not improbable, therefore, she may have in this way imbibed the reproductive sporules. In the same way aquatic animals of various species may be occasionally swallowed.

TESTS OF THE USUAL IMPURITIES IN COMMON WATERS.—The following are the tests by which the presence of the ordinary constituents or impurities of common water may be ascertained:—

1. EBULLITION.—By boiling, air and carbonic acid gas are expelled, while carbonate of lime (which has been held in solution by the carbonic acid) is deposited. The latter constitutes the fur or crust which lines tea-kettles and boilers.

2. PROTOSULPHATE OF IRON.—If a solution or crystal of this salt be introduced into a phial filled with the water to be examined, and the phial be well corked, a yellowish-brown precipitate (sesquioxide of iron) will be deposited in a few days, if oxygen gas be contained in the water (see *ante*, p. 274).

3. LITMUS.—This is a test for acids or alkalies. Blue litmus paper, or blue infusion of litmus or syrup of violets, is reddened by a free acid. Litmus paper or infusion of litmus, slightly reddened by an acid, has its blue colour restored by an alkali or alkaline carbonate.

4. LIME WATER.—This is a test for carbonic acid, with which it causes a white precipitate (carbonate of lime) if employed before the water is boiled.

5. CHLORIDE OF BARIUM.—A solution of this salt usually yields, with well-water, a white precipitate, insoluble in nitric acid. This indicates the presence of sulphuric acid (which, in common water, is combined with lime, and sometimes with soda).

6. OXALATE OF AMMONIA.—If this salt yield a white precipitate, it indicates the presence of lime (usually in the form of carbonate and sulphate).

7. NITRATE OF SILVER.—If this occasion a precipitate insoluble in nitric acid, the presence of chlorine (usually as chloride of sodium or earthy chloride) may be inferred. Nitrate of silver may also be used to detect the existence of phosphoric acid in water. In his paper on the deep-well water of the London basin, Professor Graham[3] observes, that a small deposit, chiefly consisting of carbonate and phosphate of lime, takes place when this water is considerably evaporated; and the remaining liquid gives, with nitrate of silver, a precipitate of chloride and carbonate of silver, "which is white, without any shade of yellow; but if a portion of the water, amounting to an ounce or two, be evaporated to dryness in a platinum capsule, without removing the precipitate, and the heat afterwards continued so as to raise the temperature of the resulting dry saline water to low redness,

---

[1] For an account of vegetable parasites, see Robin, *Des Végétaux qui croissent sur l'Homme et sur les Animaux vivent*, Paris, 1847.

[2] *Microscopic Journal*, vol. ii. p. 189.

[3] *Memoirs of the Chemical Society*, vol. ii. p. 392.

then, on redissolving by distilled water, and adding nitrate of silver, a precipitate is obtained, in which the yellow colour of the phosphate of silver is very perceptible. The earthy phosphate is decomposed by ignition with the alkaline [carbonate] belonging to the water, and the soluble phosphate of soda is produced." Nitrate of silver is also used as a test of organic matter (see *ante*, p. 288).

8. PHOSPHATE OF SODA.—If the lime contained in common water be removed by ebullition and oxalic acid, or oxalate of ammonia, and to the strained and transparent water ammonia and phosphate of soda be added, any magnesia present will, in the course of a few hours, be precipitated in the form of the white ammoniacal phosphate of magnesia.

9. TINCTURE OF GALLS.—This is used as a test for iron, with solutions of which it forms an inky colour (tannate and gallate of iron). If the test produced this effect on the water before, but not after, boiling, the iron is in the state of carbonate; if after as well as before, it is in that of sulphate. *Infusion of tea* may be substituted for infusion of galls, to which its effects and indications are similar. *Ferrocyanide of potassium* yields, with solutions of the sesquisalts of iron, a blue precipitate, and with the protosalts a white precipitate, which becomes blue by exposure to the air.

10. HYDROSULPHURIC ACID (*Sulphuretted Hydrogen*).—This yields a dark (brown or black) precipitate (a metallic sulphuret) with water containing lead or copper in solution —*Hydrosulphuret of ammonia* or *sulphuret of potassium* occasions a dark or black precipitate or discolouration with water containing iron, as well as with that which contains either lead or copper in solution; but the iron precipitate is readily dissolved by acids.

11. EVAPORATION AND IGNITION.—If the water be evaporated to dryness, and ignited in a glass tube, the presence of organic matter may be inferred by the odour and smoke evolved, as well as by the charring.—Another mode of detecting organic matter is by adding nitrate of lead to the suspected water, and collecting and igniting the precipitate; when globules of metallic lead are obtained if organic matter be present.[1]—The putrefaction of water is another proof of the presence of this matter.—Nitrate of silver has been already mentioned as a test, but the ammonio-nitrate is preferable.

1. AQUA PLUVIALIS; *Aqua Pluvia; Aqua Imbrium; Rain Water.*— This is the purest of all natural waters. Its composition, however, varies somewhat in different situations, owing to the foreign substances floating in the atmosphere, and with which it becomes contaminated. It contains *air, carbonic acid, salts,* and *organic matter.*

Liebig[2] has shown that rain water contains carbonate of ammonia, to which he ascribes its softness. Carbonate of lime is another constituent, as is also, according to Bergmann, chloride of calcium. The latter chemist also obtained traces of nitric acid. Zimmermann found oxide of iron and chloride of potassium in rain; but Kastner could discover no traces of iron in it, though he found meteoric iron and nickel in dew. Brandes detected various other inorganic substances, viz. chloride of sodium (principally), chloride of magnesium, sulphate and carbonate of magnesia, and sulphate of lime. He likewise mentions oxide of manganese. The putrefaction to which rain water is subject shows that some organic matter is present. The term *pyrrhin* (from πυρρός, *red*) has been applied by Zimmermann to an atmospheric organic substance which reddens solutions of silver.[3]

At the commencement of rain, especially after the long-protracted drought, the water which falls contains more foreign matter than the rain water collected after several hours or days of continued rain. The first rain which falls is contaminated with carbonate of ammonia, various other salts (sulphates and chlorides), carbonaceous matters, &c. washed out of the atmosphere. Such water, therefore, should not be collected for pharmaceutical and chemical purposes. The purest rain water is collected after a continued rain of several hours or days, and at a distance from houses. That which is collected from the roofs of houses is of course liable to contamination from various sources. Whenever rain water is collected near large towns, it should be boiled, and either strained or allowed to deposit its impurities, before use. As it contains less saline impregnation than other kinds of natural waters, it is more apt to acquire metallic impregnation from leaden cisterns and water pipes.

---

[1] See Dr. Lamb's *Investigation of the Properties of Thames Water*, p. 11, 1828; also Clement, *Annales de Chimie et de Physique*, t. iv. p. 232.

[2] *Organic Chemistry in its Application to Agriculture and Physiology*, edited by Lyon Playfair, Ph.D. London, 1840.

[3] [A. Vogel considers this effect to be produced by different kinds of organic matter, and not by one only. He has shown that this red colour is produced in a solution of nitrate of silver, when exposed to light, by solutions of roasted starch, beech wood, peat, &c. (*Translation of Gmelin's Handbook of Chemistry*, vol. ii. p. 413, Cavendish Society).—ED.]

SNOW WATER (*Aqua ex Nive; Aqua Nivalis*) is destitute of air and other gaseous matters found in rain; and hence fish cannot live in it. It has long been a popular, but erroneous opinion, that it was injurious to the health, and had a tendency to produce bronchocele. But this malady "occurs at Sumatra, where ice and snow are never seen; while, on the contrary, the disease is quite unknown in Chili and Thibet, although the rivers of these countries are chiefly supplied by the melting of the snow with which the mountains are covered."[1] Snow does not quench thirst; on the contrary, it augments it; and the natives of the Arctic regions "prefer enduring the utmost extremity of this feeling, rather than attempt to remove it by eating of snow."[2] When melted, however, it proves as efficacious as other kinds of water.

2. AQUA FONTANA; *Spring Water*.—This is rain water which, having percolated through the earth, reappears at the surface of some declivity. During its passage it almost always takes up some soluble matters, which of course vary according to the nature of the soil. Its constituents are similar to those of well water, which is also frequently termed spring water.

"For pharmaceutic use, spring water must be so far at least free of saline matter as not to possess the quality of hardness, or contain above a 6000th of solid matter."—*Ph. Ed.*

Under the name of *spring water* the Edinburgh College include also *well water*. The purity indicated in the Edinburgh Pharmacopœia for spring water is intended to apply to the springs of Scotland. Spring water of such purity is rare in England.

3. AQUA EX PUTEO; *Aqua Puteana; Well Water*.—This is water obtained by sinking wells. As it is commonly raised by means of a pump, it is frequently called *pump water*. The constituents of ordinary well water are similar to those of river water above mentioned; but the earthy salts (especially the sulphate of lime) are found in much larger quantity.

THE LONDON WELLS.—The wells in London[3] may be arranged in three classes: those in the gravel above the clay; those in the clay itself; and those which derive their supply from the strata below the clay.

1. *Wells in the diluvial gravel above the clay.*—These are shallow wells which, generally speaking, yield good drinking water, though the produce of some of them is rather hard and brackish. The supply which they yield is generally insufficient for the consumption of large manufactories. [These wells are apt to contain nitrates of lime and magnesia,

---

[1] Paris, *Pharmacologia*, 6th edit. vol. i. p. 79.

[2] *Narrative of a Second Voyage in Search of a North-West Passage, and of a Residence in the Arctic Regions during the Years* 1829, 1830, 1831, 1832, *and* 1833, p. 366, London, 1835.

[3] For a notice of the Wells in London, see Conybeare and Phillips's *Outlines of the Geology of England and Wales*; also the *Quarterly Journal of Science*, vol. xiv. p. 145, 1823.

owing to their proximity to the surface, and consequent liability to become impregnated with oxygenated nitrogenised matters. These nitrates have been traced occasionally to the decomposition of animal matters going on in neighbouring graveyards. A striking instance of the kind is mentioned by Mr. Noad, who found 40·12 grains of nitrate of lime, and 17·06 grains of nitrate of magnesia, in 100 grains of solid matters obtained by evaporating a gallon of water from a well near the old churchyard on Highgate Hill. The water from these surface wells is also sometimes impregnated with vegetable matter, and is then unwholesome, and disagreeable to the taste Such water may, however, generally be rendered fit for drinking by brisk boiling, when the vegetable matter coagulates, and sinks to the bottom.[1]—ED.]

2. *Wells in the London Clay.*—The water obtained from the blue clay is exceedingly impure. It derives its great hardness from sulphate of lime, of which it is sometimes nearly a saturated solution. Sulphate of magnesia, sulphate of soda, sulphate of iron, and occasionally sulphuretted hydrogen, are also found in these waters. The supply of these wells is scanty.

3. *Wells which derive their supply from the strata below the clay.*—These wells derive their water from the sand and plastic clay contained, beneath the London clay, in the chalk basin. Many of the wells extend some distance into the chalk. Their depth varies in different localities from 100 to 500 feet or more. The water which these deep wells of the London basin supply is remarkable for its softness, derived from the presence of carbonate of soda, and for its containing phosphoric acid. It has been analysed by Professor Graham.[2] An imperial gallon obtained from the deep well in the brewery of Messrs. Combe and Delafield, Long Acre, contained 56·45 grains of solid matter, 100 parts of which gave

Carbonate of soda	20·70
Sulphate of soda	42·94
Chloride of sodium	22·58
Carbonate of lime	10·96
Carbonate of magnesia	0·92
Phosphate of lime	0·34
Phosphate of iron	0·43
Silica	0·79
	100·66

It is obvious, therefore, that the deep well water of the London basin contains nearly three times as much solid matter in solution as deep Thames water (see *infra*).

ARTESIAN WELLS.—These are vertical cylindrical borings[3] in the earth, through which water rises, by hydrostatic pressure, either to the surface (*spouting* or *overflowing wells*), or to a height convenient to the operation of a pump.[4] They have been denominated Artesian, from a notion that they were first made in the district of Artois in France. It is probable, however, that they were known to the ancients, for a notice of them is said to occur in Olympiodorus.[5] Proposals have been made for supplying London with water by these wells, which would derive their water from the stratum of sand and plastic clay placed between the London clay and the chalk basin.[6] But it does not appear that a sufficient supply can be obtained in this way.[7] [In a work published lately,[8] and which is replete with most valuable information, Mr. Prestwich has endeavoured to show, that a sufficient supply of water might be obtained from the greensand formation beneath the chalk by means of Artesian wells. The evidence he adduces appears very satisfactory both as to quantity and quality of water which might be thus obtained.—ED.]

4. **AQUA EX FLUMINE**; *Aqua Fluvialis; River Water.*—This is a

---

[1] *Chemistry of Common Life*, by J. F. W. Johnston, M.A., No. 1, p. 40.

[2] *Memoirs of the Chemical Society*, vol. ii. p. 392.

[3] For a description of the mode of boring, and of the tools used, see Ure's *Dictionary of Arts, Manufactures, and Mines*, p. 57, London, 1839.

[4] In the *Penny Cyclopædia*, art. *Artesian Wells*, is a popular and interesting account of these wells.

[5] Passy, *Description Géologique du Département de la Seine-Inférieure*, p. 292, Rouen, 1832.

[6] See an interesting account of Artesian Wells, by Mr. Webster, in *Athenæum* for 1839, p. 131.

[7] *Ibid.*; also, *Transactions of the Institution of Civil Engineers*, vol. iii. part iii.

[8] Prestwich *On the Water-bearing Strata of London*, London, 1851.

mixture of rain and spring water. When deprived of the matters which it frequently holds in suspension, its purity is usually considerable. The following are the solid constituents of the waters of the Thames and Colne, at different localities, according to the analyses of Mr. R. Phillips:[1]—

QUANTITY OF WATER. 1 Gallon = 10 lbs. Avoirdupois, at 62° F., or 70000 grs. Avoirdupois.	THAMES WATER.			COLNE WATER.		
	Brentford. Source of the Grand Junction Water Works Company	*Barnes.* Source of the West Middlesex Water Works Company.	*Chelsea.* Source of the Chelsea Water Works Company.	*Otterpool.* Spring near Bushey	*Nain spring* in the valley that supplies the Colne	*Colne* itself.
	grs.	grs.	grs.	grs.	grs.	grs.
Carbonate of Lime........	16.000	16·900	16·500	18·800	19·300	18·100
Sulphate of Lime .... Chloride of Sodium	3·400	1·700	2·900	2·500	2·500	3·200
Oxide of Iron............ Silica.................... Magnesia................ Carbonaceous matter....	Very minute portions	ditto	ditto	ditto	ditto	ditto
Solid matter held in solution	19·400	18·600	19·400	21·300	21·800	21·300
Mechanical Impurity......	0·368	0·368	0·368	0·185	0·262	0·126
Total solid matter ..	19·768	18·968	19·638	21·485	22·062	21·426

No notice is taken in these analyses of the gaseous constituents (air and carbonic acid) of river water.

Thames water taken from the middle of the river at Twickenham, two hours after high water, on the 16th of December, 1847, had a temperature of 49°·1 Fahr., and the specific gravity of 1·0003. An imperial gallon of it contained 22·48995 grains of solid matter, consisting of carbonate of lime, soluble organic matter, insoluble organic matter, sulphate of soda, chloride of calcium, carbonate of magnesia, sulphate of potash, sulphate of lime, silicic acid, and free carbonic acid.[2]

Supply of Water to the Metropolis.[3]—London is supplied with water by eight water companies, six of which derive their water from the Thames. The East London Company derives its water from the river Lea. The New River Company derives its principal supply from a spring at Chadwell, between Hertford and Ware, and from an arm of the river Lea. The following was the amount supplied to the metropolis in 1828:—

		Gallons per diem.
North side of the Thames...	New River	13,000,000
	East London	6,000,000
	Grand Junction	2,800,000
	West Middlesex	2,250,000
	Chelsea...	1,760,000
South side of the Thames...	Lambeth	1,244,000
	Vauxhall, or South Lambeth	1,000,000
	Southwark	720,000
	Total daily supply..................	28,774,000

[A great increase has taken place since 1828 in the amount of water supplied by these Companies. Thus, for 1849, we find the following return:—

---

[1] *Report from the Select Committee of the House of Lords appointed to inquire into the Supply of Water to the Metropolis*, p. 91, 1840. See also Dr. Bostock's analysis, in the *Report of the Commissioners appointed to inquire into the state of the Supply of Water in the Metropolis*, 1828.

[2] G. F. Clarke, in the Proceedings of the Chemical Society (*Pharm. Journal*, vol. vii. p. 591).

[3] See the *Report of the Commissioners appointed by His Majesty to Inquire into the State of the Supply of Water in the Metropolis* (*Quarterly Journal of Science*, April 1828). Also, Sir William Clay, Bart. *On the Water Supply of London*, 1849.

	Gallons per diem.
New River	14,149,315
East London	8,829,462
Grand Junction	3,532,013
West Middlesex	3,334,054
Chelsea	3,940,730
Lambeth	3,077,260
Southwark and Vauxhall	6,013,716

The subject of water supply is at present receiving marked attention from the legislature, and every possible source is being examined into with the object of getting water of good quality in sufficient quantity, and such as will not become contaminated by contact with lead,—the water service of this country being nearly all carried on in leaden vessels.—ED.]

5. AQUA EX LACU; *Lake Water.*—This is a collection of rain, spring, and river water, usually contaminated with putrefying organic matter.

6. AQUA EX PALUDE; *Marsh Water.*—This is analogous to lake water, except that it is altogether stagnant, and is more loaded with putrescent matter. The sulphates in sea and other waters are decomposed by putrefying vegetable matter, with the evolution of sulphuretted hydrogen: hence the intolerable stench from marshy or swampy grounds liable to occasional inundations from the sea (see p. 72, foot note).

Aqua Marina.—Sea Water.

(Aqua maris.)

Under this head are included the waters of the ocean and of those lakes, called inland seas, which possess a similar composition. The Dead Sea, however, differs exceedingly in its nature from sea water, and might properly be ranked amongst mineral waters.

The water of the Dead Sea contains, according to Marcet's[1] analysis, 24·6 per cent. of saline water, and has the extraordinary density of 1·211. [Gay Lussac gives the proportion of saline matter contained in this water at 26·24 per cent., and Gmelin gives it at 24·53 per cent. A few years since we had an opportunity of examining a portion of this water. The quantity of saline matter obtained by evaporation amounted to 24 per cent. It was perfectly white, very deliquescent, and intensely bitter. The analyses of all chemists agree in showing that one-half of the saline matter consists of *chloride of magnesium*, while the remainder is formed chiefly of *chloride of sodium*, with traces of other chlorides. It contains no carbonate of lime, and only a trace of sulphate. Gmelin found in this water a quantity of bromide of magnesium amounting to 0·44 per cent. by weight. No chemist has yet discovered in it any trace of iodine.

The sample which we examined had a specific gravity of 1·117. It was rather turbid, and deposited a small quantity of ochreous sediment on standing: this was derived from the tinned iron vessel in which the water had been brought to us from the Holy Land. Its taste was strongly saline, nauseous, and intensely bitter. By evaporation it left on the hands a saline deliquescent deposit. Different parts of the dead human body were placed in this water. Fat, muscle, ligament, skin, and portions of the soft organs, readily floated on it. The only structures which sunk were bone and cartilage. As the skeleton forms only one-twelfth part of the weight of the body, the great buoyancy of the human body in this sea-water is at once explained. There is no water in the world which contains so much saline matter as this. The proportion, at the lowest estimate, amounts to 16,800 grains in the imperial gallon.

We may also observe, that we have had an opportunity of examining the water of the Jordan, which empties itself into this sea The Jordan water differs from other river water in containing scarcely a trace of carbonate of lime. It contains about the same proportion of sulphate of lime as Thames water, but the quantity of chloride of sodium is much greater than in river water. The Dead Sea, however, chiefly derives its salt from the saliferous rocks which form its basin. While its surface is 1500 feet below the level of the Mediterranean, its depth has been fathomed to 2226 feet; and from this depth, the deep sea lead brought up particles of rock salt. Owing to the great depression of its surface, it is the chief receptacle of the drainage of the sandy saliferous plains of this part of Syria.—ED.]

---

[1] Nicholson's *Journal*, xx. 25.

The quantity of solid matter varies considerably in different seas, as the following statement from Pfaff[1] proves:—

10,000 *Parts of Water of*		*Solid Constituents.*
The Mediterranean Sea		410 grs.
English Channel		380 ,,
German Ocean	At the Island of Föhr	345 ,,
	,, Norderney	342 ,,
	In the Frith of Forth	312 ,,
	At Ritzebüttel	312 ,,
Baltic Sea	At Apenrade, in Sleswick	216 ,,
	At Kiel, in Holstein	200 ,,
	At Doberan, in Mecklenberg	168 ,,
	At Travemünde	167 ,,
	At Zoppot, in Mecklenberg	76 ,,
	At Carlshamm	66 ,,

We shall not be far from the truth if we assume that the average quantity of saline matter is 3½ per cent., and the density about 1·0274.

The composition of sea water, according to Schweitzer[2] and Laurens, is as follows:—

Constituents.	*Of the English Channel.* (SCHWEITZER.)		*Sea Water of the Mediterranean.* (LAURENS.)
	Grains.		Grains.
Water	964·74372		959·26
Chloride of sodium	27·05948		27·22
,, potassium	0·76552		0·01
,, magnesium	3·66658		6·14
Bromide of magnesium	0·02929		—
Sulphate of magnesia	2·29578		7·02
,, lime	1·40662		0·15
Carbonate of lime	0·03301	and Magnesia ...	0·20
	1000·00000		1000·00

Schweitzer also detected distinct traces of iodine and ammonia.

Iodine has been found in the Mediterranean by Balard.

[Dr. Davy places carbonate of lime among the constituents of sea water, especially as obtained near shore. He has shown, however, that it exists, dissolved in carbonic acid, in sea water 50 and 100 miles from land.[3] Silver, lead, and copper, are to be detected in sea water, according to the experiments of MM. Sarzeau, Malaguti, and Durocher: they operated on water taken some few leagues from the coast of St. Malo.[4]—ED.]

Forchammer[5] asserts that though the total solid contents of the water of the Atlantic vary from 3·57 (German Sea) to 3·66 (tropics) per cent. of the water, yet that the relative proportion of the salts varies but little. [This is also shown by the analyses of Von Bibra, who examined the waters of the Atlantic, Pacific, and German Oceans. He discovered bromide of sodium in every specimen.[1]—ED.]

---

[1] Schwartze's *Allgemeine und specielle Heilquellenlehre*, 2te Abt. S. 186, Leipsic, 1839.

[2] *Lond. and Edinb. Phil. Mag.* xv. 51, July 1839.

[3] *Phil. Mag.* Sept. 1849.

[4] *Comptes Rendus*, Dec. 26, 1849.

[5] *Reports of the British Association*, 1846, p. 90.

PHYSIOLOGICAL EFFECTS AND USES.—Sea water, taken internally, excites thirst, readily nauseates, and, in full doses, occasions vomiting and purging. The repeated use of it, in moderate doses, has been found beneficial, on account of its ålterative and resolvent operation in scrofulous affections, especially glandular enlargement and mesenteric diseases. Its topical action is more stimulant than common water. It is used as an embrocation in chronic diseases of the joints. Employed as a bath, it more speedily and certainly causes the reaction and glow; and consequently the sea-water bath may be used for a longer period, without causing exhaustion, than the common water bath. In other respects its effects, as a bath, are similar to those of common water (see *ante*, pp. 20 and 28.) It is a popular opinion, which is perhaps well founded, that patients are less likely to take cold after the use of salt water, as a bath, than after the employment of common water.[2]

Fresh water may be obtained from sea water either by congelation or distillation. In freezing, the pure water only congeals, not the saline matters: and hence the ice of the Polar seas yields fresh water. By distillation, pure wholesome fresh water may be obtained from sea water; but hitherto various inconveniences and objections have prevented mariners being supplied with fresh water from this source.[3]

From sea water are procured chloride of sodium and sulphate of magnesia.

BALNEUM MARIS FACTITIUM; *Artificial Sea Water Bath.*—A cheap substitute for a sea water bath is prepared by dissolving common salt in water in the proportion of five ounces avoirdupois to every wine gallon of water.

3. *Aquæ Minerales.—Mineral Waters.*

HISTORY.—Mineral waters were known to mankind in the most remote periods of antiquity, and were employed medicinally, both as external and internal agents, for the prevention, alleviation, and cure of diseases. Homer[4] speaks of tepid and cold springs. The Asclepiadæ, or followers of Æsculapius, erected their temples in the neighbourhood of mineral and thermal waters.[5] Hippocrates[6] speaks of mineral waters, though he does not prescribe them, when speaking of particular diseases. Pliny[7] notices their medicinal properties.

NATURAL HISTORY.—The principal source of mineral waters is the atmosphere, from which water is obtained in the form of rain, snow, hail, and dew, and which, after percolating a certain portion of the earth, and dissolving various substances in its passage, reappears on the surface at the bottom of declivities (*spring water*), or is procured by sinking pits or wells (*well water*). But springs are sometimes observed under circumstances which are inconsistent with the supposition of their atmospheric origin. "The boiling springs which emerge on the verge of perpetual snows, at an altitude of 13,000 feet above the level of the sea, as in the Himalayahs, cannot be derived from the atmosphere, not to mention the peculiar relations of the Icelandic Geysers."[1] Other sources, therefore, have been sought for, and the writer just quoted enumerates three; viz. the focus of volcanic activity, the great mass of the ocean, or other masses of salt and subterranean reservoirs.

---

[1] *Ann. der Chem. u. Pharm.* Bd. lxxvii.; and *Central-Blatt*, No. 23, 1851, p. 362.

[2] On the medicinal properties of sea water, consult Logan's *Observations on the Effects of Sea Water in Scurvy and Scrophula*, Lond. 1770; and Dr. R. White, on *The Use and Abuse of Sea Water*, Lond. 1775.

[3] Clark's *Patent Improved Pyro-hydro-pneumatic Apparatus for easily converting Sea Water into Fresh*, is a convenient form of still adapted for use at sea.

[4] *Iliad*, xxii. 147.

[5] Sprengel, *Hist. de Médec.* par Jourdan, tome i. p. 144.

[6] *De aeribus, aquis, locis.*

[7] *Hist. Nat.* lib. xxxi.

Considered with reference to their temperature, mineral waters are divided into *cold* and *hot*. The hot or thermal waters are those which possess a temperature more or less elevated above the mean of the latitude or elevation at which they are found, and the changes of which, if any, observe no regular periods coincident with the revolutions of the seasons. Three causes have been assigned as the source of the heat of mineral waters, viz. volcanic action now in existence; volcanic action now extinguished, but the effects of which still remain; and a central cause of heat, which increases as we descend from the surface to the interior of the earth.[2]

The *Geysers*, or boiling springs, of Iceland, are evidently connected with volcanic action. They are intermittent fountains, which throw up boiling water and spray to a great height into the air.[3]

The origin of the saline and other constituents is another interesting topic of inquiry connected with the natural history of mineral springs. As water in its passage through the different strata of the earth must come in contact with various substances which are soluble in it, we refer certain constituents of mineral waters to solution and lixiviation merely; as chloride of sodium, carbonates of lime and magnesia, iodides and bromide of sodium and magnesium, iron, silica, &c. Chemical action must, in some cases, be the source of other constituents. Thus sulphuretted hydrogen is probably produced by the action of water on some metallic sulphuret (especially iron pyrites); sulphurous or sulphuric acid, from the oxidation and combustion of sulphur, free or combined. The carbonic acid found in the acidulous or carbonated waters is referable to the decomposition of carbonate of lime, either by heat or by the action of sulphuric acid. Hydrochloric acid is doubtless produced by the decomposition of some chloride (probably chloride of sodium or sal ammoniac). Carbonate of soda must also be considered as the product of some chemical process: thus, that found in the natron lakes of Egypt is supposed to be formed by the action of chloride of sodium on carbonate of lime.[4] "The different orifices of the Karlsbad Sprudel discharge annually about 13,000 tons of carbonate of soda and 20,000 of the sulphate in the crystallized state;"[5] but a "very simple calculation is sufficient to shew that the Donnersberg alone, the loftiest of the Bohemian Mittelgebirge, a cone of clinkstone 2,500 feet in elevation, contains soda enough to supply the Karlsbad waters alone for more than 30,000 years."[1]

---

[1] Gairdner's *Essay on Mineral and Thermal Springs*, p. 289.

[2] Gairdner, *op. cit.*

[3] For further information concerning them, I must refer to Sir G. S. Mackenzie's *Travels in Iceland during the Summer of* 1810, Edinb. 1811; and to Barrow's *Visit to Iceland by way of Tronyem, &c. in the Summer of* 1834, Lond. 1835.

[4] Berthollet, *Essai de Statique Chimique*, part i p. 406.

[5] Gairdner, *op. cit.* p. 325.

CLASSIFICATION —Mineral waters may be classified according to their temperature, their chemical composition, or their medicinal properties. But hitherto no satisfactory classification has been effected by any of the methods, nor perhaps can it be formed.

The method adopted by Paracelsus and the alchymists was to divide mineral waters according to their temperature into the two great classes of *hot* and *cold*, and to subdivide each of these according to their supposed constituents. The following is Dr. Gairdner's classification according to this method :—

SERIES I.—THERMAL.

CLASS.

1. SULPHUREOUS. Predominant constituent, *Sulphuretted Hydrogen :*
   e. g. Barèges, Aix-la-Chapelle.
2. ALKALINE. Pred. const. *Carbonate of Soda :*
   e. g. Elms, Teplitz, Vichy, Mont-d'Or, Ischia.
3. PURGING. Pred. const. *Sulphate of Soda :*
   e. g. Karlsbad, d'Ax, Pisa.
4. SALINE. Pred. const. *Chloride of Sodium :*
   e. g. Wiesbaden, Bourbon l'Archambault, Civitá Vecchia, Baden in Baden.
5. CALCAREOUS. Pred. const. *Carbonate* or *Sulphate of Lime :*
   e. g. Bath, Buxton, St.-Allyre.
6. SILICEOUS. Pred. const. *Silica :*
   e. g. Geyser, Chaudes Aigues, Luxueil, Mariara.
7. PURE. Little or no impregnation :
   e. g. Matlock, Vic en Carlades.

SERIES II.—COLD.

CLASS.

1. SULPHUREOUS. Predominant constituent, *Sulphuretted Hydrogen :*
   e. g. Harrowgate, Moffat, Nenndorff.
2. ACIDULOUS. Pred. const. *Carbonic Acid Gas :*
   e. g. Pyrmont, Selters, Asciano.
3. ALKALINE. Pred. const. *Carbonate of Soda :*
   e. g. Vals, Bilin, Malvern.
4. PURGING. Pred. const. *Sulphate of Soda :*
   e. g. Cheltenham, Franzensbad, Marienbad.
5. SALINE. Pred. const. *Chloride of Sodium :*
   e. g. Leamington, Rennes, Bourbonne-les-Bains.

(5.) BRINE SPRINGS. Pred. const. *Chloride of Sodium :*
   e. g. Ashby-de-la-Zouch, Kreuznach, Ischl, Bex.

6. CHALYBEATE. Pred. const. *Oxide of Iron :*
   e. g. Tunbridge, Spa.
7. ALUMINOUS CHALYBEATE. Pred. const. *Sulphates of Iron and Alumina :*
   e. g. Isle of Wight, Hartfell, Alexisbad.
8. BITTER. Pred. const. *Sulphate of Magnesia :*
   e. g. Saidschütz, Seidlitz, Epsom.

This arrangement is objectionable on two grounds: the two series of thermal and cold waters pass into each other by almost insensible gradations; and secondly, waters of analogous chemical composition, and, therefore, of similar medicinal properties, are separated on account of their difference of temperature.

The classification which I shall adopt is convenient on account of its simplicity and practical utility. It consists in grouping mineral waters in four classes, respectively termed *chalybeate*, *sulphureous*, *acidulous*, and *saline*.

CLASS 1. CHALYBEATE OR FERRUGINOUS WATERS.

(Aquæ ferruginosæ seu martiales.)

These are mineral waters whose predominating or active principle is *iron*. Most mineral waters contain this metal, but the term chalybeate is not applied to them unless the quantity of iron be considerable in proportion to the other constituents.

---

[1] Gairdner, *op. cit.* p. 338.

The quantity of oxide of iron contained in different waters is shewn by the following table:—

DR. M. GAIRDNER'S TABLE OF THE QUANTITY OF OXIDE OF IRON CONTAINED IN CHALYBEATE WATERS.

	10,000 *Grs. of the Water.*	*Grs. of Oxide of Iron.*	*Authority.*
THERMAL	Bath in England	0·0271	R. Phillips.
	Bourbon l'Archambault in France	2·579	Patissier.
	Mont-d'Or in ditto	0·10	Berthier.
	Vichy in ditto	1·385	Longchamps.
	St.-Nectaire in ditto	0·14	Berthier.
	Chaudes Aigues in ditto	0·15	Ditto.
	Champagne in ditto	0·1573	Patissier.
	Karlsbad Sprudel in Bohemia	0·022	Berzelius.
	Teiplitz Steinbad in ditto	0·03	Ditto.
COLD	Tunbridge in England	0·381	Scudamore.
	Harrowgate (Oddy's saline chalyb.) in ditto	0·411	Ditto.
	Isle of Wight (albuminons chalyb.) in ditto	14·79	Marcet.
	Holywell, Lancashire, in ditto	2·396	perox. ir. Woolworth.
	Hartfell Spa, near Moffat, in Scotland	0·825	Thomson.
	Ditto, No. 2	34·2	Ditto.
	Vicar's Bridge, near Dollar, in ditto	312·0	Connel.[1]
	Dunblane in ditto	0·233	Murray.
	Forges in France	1·128	Robert.
	Aumale in ditto	2·50	Diezengremel.
	Passy in ditto	0·679	Deyeux.
	Vals in ditto	0·06	Berthier.
	Alexisbad, Bernburg, in Germany	2·348	Graefe.
	Buckowina in Silesia (lower spring)	2·090	Lachmund.
	Liebenstein in Thuringia	1·66	Trommsdorff.
	Godelheim (bathing spring)	1·489	Witting.
	Lauchstadt	1·018	
	Spa	0·746	Monheim.
	Pyrmont (drinking spring)	0·611	Brandes.
	Kissengen	0·421	Vogel.
	Bruckenau in Franconia	0·210	Schipper.
	Karlsbad (acidulous spring)	0·03	Berzelius.
	Königswart (drinking spring)	0·38	Ditto.
	Bilin	0·10	Reuss.
	Geilnau on the Lahn	0·128	Bischof.
	Fachingen on ditto	0·077	Ditto.
	Selters in Nassau	0·124	Ditto.
	Marienbad, Caroline well	0·369	Steinman and Reuss.
	Engistein, Canton of Bern in Switzerland	0·875	Pagenstecher.
	Schmerikon, Canton of Gallen in ditto	1·086	Hüttenschmidt.
	St. Catarina, Canton Veltlin in ditto	2·466	Demagri.
	Lipewsk in Russia	1·0 to 2·0	Scherer.
	Ballstown, New York, United States	3·332	Hosack.

Chalybeate waters have an inky or styptic taste, and become purplish-black on the addition of tannic or gallic acid (or substances, as galls and tea, which contain one or both of these acids). [We have known this change of colour produced by the admixture of aerated waters with certain wines, to the great alarm of persons unacquainted with the fact here pointed out.—ED.] Waters which contain the protosalts of iron yield, on the addition of ferrocyanide of potassium, a white or blueish-white precipitate, which becomes blue by exposure to the air. Those which contain the sesquisalts of iron give a blue precipitate with ferrocyanide of potassium.

---

[1] This can scarcely be called a true mineral water, being somewhat analogous to the pools in copper mines of England and Sweden, which hold copper in solution,—a substance not found in true mineral springs. As it is, however, an example of a purely natural process, I have deemed it worthy of a place among the other waters.—M. G.

Chalybeate waters are of two kinds,—carbonated and sulphated.

Order 1. Carbonated Chalybeate Waters (*Aquæ ferruginosæ carbonicæ*). — These waters contain the carbonate of the protoxide of iron. By exposure to the air, or by boiling, they extract oxygen, evolve carbonic acid, and deposit the whole of the iron in the form of sesquioxide.

When the carbonate of iron is associated with a large quantity of carbonic acid, which renders the water brisk, sparkling, and acidulous, they are denominated *highly carbonated* or *acidulo-carbonated chalybeates*, or *acidulo-ferruginous waters*. The Pyrmont (Trinkquelle, or drinking spring), Schwalbach, and Spa (Pouhon) waters are of this kind.

When, however, the quantity of carbonic acid is not large, and the waters do not sparkle in the glass, they are termed *simply carbonated chalybeates*, or, from the earthy and alkaline salts which they contain, *saline carbonated chalybeates*. The waters of Tonbridge Wells, Oddy's saline chalybeate at Harrowgate, and the Islington Spa near London, are of this kind.

Osann[1] and Schwartze[2] divide the carbonated chalybeate into the *earthy saline*, (*e. g.* Pyrmont), the *alkaline-saline* (*e. g.* Franzensbad or Egar), the *alkaline-earthy* (*e. g.* Spa), and the *earthy* (*e. g.* Wildungen).

Order 2. Sulphated Chalybeates. (*Aquæ vitriolicæ*).—These contain sulphate of iron, and some of them also contain chloride of iron. Neither exposure to the air nor boiling precipitates all the iron, and in this respect the sulphated chalybeates are distinguished from the carbonated ones.

Some of them contain sulphate of alumina, and are denominated *aluminous sulphated chalybeates*. Of these the Sand Rock Spring in the Isle of Wight, the Strong Moffat Chalybeate, Vicar's Bridge Chalybeate, and the Passy waters, are examples. The waters of Buckowina, in Silesia, are of this kind; but they contain also chloride of iron.

The Cransac waters contain, besides the sulphate of the sesquioxide of iron and sulphate of alumina, a considerable quantity of sulphate of manganese; in consequence of which they have been denominated the *sulphated ferro-manganesian waters*.[3]

Those sulphated chalybeates which are devoid of sulphate of alumina may be termed *simply sulphated chalybeates*. The Alexisbad or Selken-Brunnen contain both sulphate and chloride of iron, but are devoid of sulphate of alumina.

The chalybeate waters operate in a similar manner to the other ferruginous compounds already noticed (see *ante*, p. 193).

The acidulated carbonated chalybeates sit more easily on the stomach than other ferruginous agents, in consequence of the excess of carbonic acid which they contain.

The aluminous chalybeates are very apt to occasion cardialgia, especially if taken in the undiluted state.

The use of chalybeate waters is indicated in cases of debility, especially when accompanied with that condition of system denominated anæmia. They have long obtained a high celebrity for the relief of complaints peculiar to the female sex. Their employment is contraindicated in plethoric, inflammatory, and febrile conditions of system.

---

[1] *Physikal. u. med. Darstellung der Heilquellen*, 3 Bde. 1842.

[2] *Allgemeine und specielle Heilquellenlehre*, folio, Leipzig, 1839.

[3] See *Notice sur les Eaux Minérales Naturelles de Cransac, département de l'Aveyron; Eaux Ferro-Manganésiennes, sulfatées*, par le Dr. Ducoux (de Blois), Paris, 1847; an English translation of the preceding, with some additions and modifications, entitled *The Mineral Waters and Vapour Baths of Cransac*, London, 1847; also, *Traité sur la Nature et les Propriétés des Eaux Minérales et Etuves de Cransac*, par M. J. F. V. Murat, 3ème éd. Rodez, 1843.

CLASS 2. SULPHUREOUS OR HEPATIC WATERS.

(Aquæ sulphureæ seu hepaticæ.)

These waters are impregnated with hydrosulphuric acid (sulphuretted hydrogen); in consequence of which they have the odour of rotten eggs, and cause black or brown precipitates (metallic sulphurets) with solutions of the salts of lead, silver, copper, bismuth, &c. Those sulphureous waters which retain, after ebullition, their power of causing these precipitates, contain a sulphuret (hydrosulphuret), usually of calcium or sodium, in solution. All the British sulphureous waters are cold, but some of the continental ones are thermal. The most celebrated sulphureous waters of England are those of Harrowgate;[1] those of Scotland are Moffat and Rothsay; of the continent, Enghien, Barèges, Aix (near Geneva), Aix-la-Chapelle[2] (or Aachen), and Baden.

DR. M. GAIRDNER'S TABLE OF THE QUANTITY OF SULPHURETTED HYDROGEN IN SULPHUREOUS WATERS.

	100 *Cubic inches of the Water of*	*Cub. inches of Gas.*	*Authority.*
THERMAL	Barèges in the Pyrenees, contains	20·0	Lüdemann.
	Cauterets in ditto	50·0	Ditto.
	St. Sauveur in ditto	16·6	Ditto.
	Schinznach in C. Aargau in Switz.	30·11	Peschier.
	Aachen in the Lower Rhine	45·78	Monheim.
	Warmbrunn in Silesia	17·17	Osann.
	Landeck in county of Glatz	14·88	Ditto.
	Baden near Vienna	11·83	Ditto.
COLD	Harrowgate in England (old well)	5·94	Scudamore.[3]
	Moffat in Scotland	7·58	Thomson.
	Strathpeffer in ditto (upper well)	9·44	Ditto.
	Enghien in France	1·60	Longchamps.
	Nenndorff in Hesse	40·90	Osann.
	Winslar in Hanover	51·51	Ditto.
	Eilsen in Lippe	27·21	Ditto.
	Meinberg in ditto	30·91	Ditto.
	Weilbach in Nassau	22·32	Ditto.[4]
	Berka in Thuringia	20·60	Ditto.
	Bocklet in Franconia	17·17	Ditto.
	Doberan in Mecklenburg	18·20	Ditto.
	Bentheim in Germany	15·45	Ditto.
	Sironabad in Hesse	2·63	Büchner.
	Dinkhold in Nassau	8·6	Kolb.

The sulphureous waters have been divided into four kinds, viz. the *alkaline-muriatic* (*e. g.* Aix-la-Chapelle), the *alkaline-saline* (*e. g.* Warmbrunn and Weilbach), the *earthy-saline* (*e. g.* Enghien), and the *ferruginous saline* (*e. g.* Neumarkt and Rosenheim).

The general operation of the sulphureous waters is stimulant, and is adapted for chronic complaints.[1] They are supposed to possess a specific power over the cutaneous and uterine systems. They are employed both as external and internal agents; in chronic skin diseases (as lepra, psoriasis, scabies, pityriasis, herpes, &c.); in derangements of the uterine functions (amenorrhœa and chlorosis); in old syphilitic cases; in chronic rheumatism and gout; and in other diseases in which sulphur or its compounds have been found serviceable (see *ante*, p. 187). On account of their stimulant effects, they are contraindicated in all plethoric and inflammatory conditions of the system, and their employment requires caution, especially in weak and irritable constitutions.

---

[1] See Dr. A. Hunter's *Treatise on the Mineral Waters of Harrowgate*, London, 1830.

[2] See Wetzlar's *Description of the Mineral Springs of Aix-la-Chapelle and Borcette*, 1842.

[3] I have not admitted the waters of Cheltenham into this list, in consequence of the extreme inconstancy of the sulphureous impregnation. Other reasons, however, render it very doubtful if any of the analyses of some of the recent springs represent their *natural* composition.—M. G.

[4] 30·9, Creve (*Stiffl's Nassau*, p. 577).—M. G.

CLASS 3. ACIDULOUS OR CARBONATED WATERS.

(Aquæ acidulæ.)

These waters owe their remarkable qualities to carbonic acid gas, which gives them an acidulous taste, a briskness, a sparkling property, and the power of reddening litmus slightly, but fugaciously, and of precipitating lime and baryta waters. When they have been exposed to the air for a short time, this gas escapes from them, and the waters lose their characteristic properties.

Most mineral and common waters contain a greater or less quantity of free carbonic acid. Ordinary spring or well waters do not usually contain more than three or four cubic inches of carbonic acid gas in 100 cubic inches of water. Dr. Henry found, in one experiment, 3·38 inches.[2] But the waters called acidulous or carbonated contain a much larger quantity. Those which have from 30 to 60 cubic inches of gas are considered rich; but the richest have from 100 to 200 or more inches.[3] Alibert[4] states that the waters of Saint Nectaire contain 400 cubic inches in 100 of the water. Most of the waters of this class contain carbonate or bicarbonate of soda: these are termed *acidulo-alkaline*. The Selters[5] (often called Seltzer), Altwasser, Salzbrunn, Reinerz, and Pyrmont (acidulous) waters, are of this kind. Frequently they contain carbonate of the protoxide of iron also: they are then termed the *acidulous carbonated chalybeates*, which have been already noticed (see *ante*, p. 305). The only acidulous or carbonated spring in Great Britain is that of Irkeston, near Nottingham, and which has been described by Mr. A. F. A. Greeves[6] and by Dr. T. Thomson.[7]

The acidulous or carbonated waters have been divided into four kinds, viz. the *alkaline-muriatic* (*e. g.* Selters); the *earth-muriatic* (*e. g.* Kissingen [Maxbrunnen]); the *earthy-alkaline* (*e. g.* Salzbrunn); and the *ferruginous* (*e. g.* Geilnau).

---

[1] See some *Observations on the Efficacy of Sulphureous Waters in Chronic Complaints*, by Dr. J. Armstrong, in his *Practical Illustrations of the Scarlet Fever*, 2d edition, London, 1818.

[2] Thomson's *System. Chem.* 6th edit. vol. iii. p. 193.

[3] Gairdner, *op. cit.* p. 30.

[4] *Nouveaux Élémens de Thérapeutique*, 5ème édit. tom. iii. p. 517.

[5] See some *Experiments relative to the Analysis and Virtues of Seltzer Water*, by Dr. Brocklesby, in the *Medical Observations and Inquiries*, vol. iv. p. 7, 2d edit. London, 1772.

[6] *Account of the Medicinal Water of Ilkeston*, 1833.

[7] *Cyclopædia of Practical Medicine*, art. *Waters, Mineral.*

DR. M. GAIRDNER'S TABLE OF THE QUANTITY OF CARBONIC ACID IN ACIDULOUS WATER.

	100 *Cubic Inches of Water of*	*Cub. Inches of Gas.*	*Temp.*	*Authority.*
THERMAL	Bath in England, contains	4·16	114°F.	R. Phillips.
	Bristol in ditto	12·99	74	Carrick.
	Buxton in ditto	0·649	82	Scudamore.
	St.-Nectaire in France	400·0	75	Alibert.[1]
	Karlsbad in Bohemia	110·0	165	Berzelius.
	Gurgitello in Ischia	89·14	122	Giudice.[2]
	Carratraca in Spain	10·70	66	Alibert.
	Maschuka in the Caucasus	60·9	118	Hermann.
	Eisenberg in ditto	32·7	103	Ditto.
	Petersquellen in ditto	2·0	195	Ditto.
	Schlangenbad in Nassau (Schachtbrun)	6·0	87	Kastner.
	Ems in ditto (Kränchesquelle)	59·9	86	Ditto.
	Ditto (at Wall of Lahn)	42·1	123	Ditto.
	Wiesbaden in ditto (No. 1)	19·7	158	Ditto.
COLD.	Tunbridge in England	3·485	...	Scudamore.[3]
	Harrowgate in ditto (old sulphur well)	4·125	...	Ditto.
	Cheltenham in ditto (old well)	12·50	...	Fothergill, 1788.
	Pitcaithly in Scotland	3·463	...	Murray.
	Andabra in France	100·0	...	Berard.
	Enghein les Bains in ditto	0·674	...	Longchamps.[4]
	Godelheim in Germany	224·9	...	Witting.
	Cudowa in County of Glatz	202·6	...	Mogalla.
	Pyrmont in Germany	151·1	...	Brandes.
	Königswarth in Bohemia	139·1	...	Wetzler.
	Schwalheim in the Wetterau	129·0	...	Wurzer.
	Bocklet in Franconia	112·5	...	Vogelmann.
	Franzensbad in Bohemia	88·67	...	Trommsdorff.
	Geilnau on the Lahn	163·2	...	Bischoff.
	Fachingen on ditto	134·8	...	Ditto.
	Selters in Nassau (Nieder)	108·7	...	Ditto.
	Liebenstein in Thuringia	109·9	...	Trommsdorff.
	Tarasp in Switzerland	109·9	...	Capeller.
	Kissingen in Germany	85·85	...	Vogel.
	Imnau in Wurtemburg	89·28	...	Kielmayer.
	Alexandersbad	94·09	...	Hildebrandt.
	Bilin in Bohemia	74·69	...	Reuss.
	Schwalbach in Nassau	73·83	...	Rube.
	Spa in Belgium	74·45	...	Monheim.
	Ballstown, State of New York	300.0	...	Hosack.
	Kislawodsk in the Caucasus	151·2	...	Hermann.
	Dinkhold in Nassau	143·9	...	Kolb.
	Oberlahnstein in ditto	55·6	...	Amburger.
	Marienfels in ditto	92·5	...	Kastner.
	Soden in ditto	88·0	...	Meyer.
	Cronberg in ditto	106·2	...	Ditto.
	Montabaur in ditto	58·8	...	Jacobi.
	Braubach in ditto (Salzhorn)	58·4	...	Bruckmann.
	Langenschwalbach (Weinbrunn)	89·1	...	Kastner.
	Marienbad in Bohemia (Kreutzbr.)	125·0	...	Struve.
	Saidschütz in ditto	20·0	...	Ditto.
	Püllna in ditto	6·9	...	Ditto.[5]

---

[1] I have assumed the coldest spring to be that which contains this large quantity of gas, which is not particularly specified: there are seven springs, ranging from 74° to 104° F.—M. G.

[2] Viaggio Medico. Half of the acid escapes at 144°, and the whole at 167°.—M. G.

[3] After being heated to 144° F. it contained 2·736.—M. G.

[4] Parts by weight in 10,000 of water.—M. G.

[5] In all these instances the carbonic acid was obtained by boiling, which expels not only the acid which is in an uncombined state in the natural water, but also the excess, which goes to convert the carbonates of acidulous waters into bicarbonates.—M. G.

Those acidulous waters which owe their medicinal activity principally to the carbonic acid which they contain, act chiefly on the digestive, renal, and nervous systems; but their effects are transient. They are cooling, refreshing, and exhilarating, and frequently relieve nausea. They augment and alter the renal secretion. Sometimes they occasion a sensation of fulness in the head, or even produce slight temporary intoxication. They are used in some disordered conditions of the digestive organs, especially when connected with hepatic derangement, in dropsical complaints, in uterine affections, and in various other cases, which will be more fully noticed when treating of carbonic acid. When the acidulous waters contain the protocarbonate of iron, their effects and uses are analogous to those of the ferruginous springs already noticed.

The acidulo-alkaline waters are useful in the lithic acid diathesis, in gout and rheumatism, &c.

The acidulous or carbonated waters are considered to be objectionable in febrile, inflammatory, and plethoric subjects.

CLASS 4. SALINE WATERS.

(Aquæ salinæ.)

These waters owe their medicinal activity to their saline ingredients; for although they usually contain carbonic acid, and sometimes oxide of iron or hydrosulphuric acid, yet these substances are found in such small quantities as to contribute very slightly only to the medicinal operation of the water.

Saline mineral waters may be conveniently divided into five orders, founded on the nature of the predominating ingredient.

Order 1. Purging Saline Waters.—The leading active ingredient of the waters of this order is either the sulphate of soda or the sulphate of magnesia; but the chlorides of calcium and magnesium, which are usually present, contribute to their medicinal efficacy.

The purging saline waters are of two kinds: some owe their activity to sulphate of magnesia, others to sulphate of soda.

α. *Bitter Purging Waters; Bitter Waters; Bitter-salt Waters.*—In these waters sulphate of magnesia predominates. The waters of Epsom and Scarborough[1] in England, and of Seidlitz, Saidschütz, and Püllna, on the continent, are of this kind. Some thermal waters, as those of Acqua del Pozzeto, near Pisa, contain sulphate of magnesia.

β. *Glauber-salt Waters.*—This name is given by some writers on mineral waters to those waters which owe their purgative qualities to sulphate of soda.

Some of these are warm, and possess alkaline qualities; and they are therefore called the *warm alkaline glauber-salt waters.* To this division belong the Carlsbad[2] waters.

Some are cold and alkaline, and are termed *cold alkaline glauber-salt waters;* as those of Marienbad (the Kreuzbrunnen and Ferdinandsbrunnen) and Franzensbrunn (the Salzquelle).

Some are devoid of alkaline properties, but contain, besides sulphate of soda, various earthy and alkaline salts. They are the *earthy glauber-salt waters.* To this division belong the springs of Cheltenham,[3] Leamington,[4] and Spital.

---

[1] See Dr. Short's *Natural, Experimental, and Medicinal History of the Mineral Waters of Derbyshire, Lincolnshire, and Yorkshire, particularly of Scarborough*, London, 1734.

[2] See Kreysig, *On the Internal Use of the Mineral Waters of Carlsbad, Marienbad, Ems*, &c., translated by Thomson, 1824.

[3] See Dr. Scudamore on Cheltenham waters, in his work on Mineral Waters, before quoted; also Maccabe's *Treatise on the Cheltenham Waters*, London.

[4] See Dr. Lambe's analysis, in the *Manchester Memoirs*, vol. v.; also Dr. Scudamore's work before quoted, and Dr. Loudon's *Practical Dissertation on the Waters of Leamington Spa*, 1828.

In full doses, the waters of this order are mild cathartics. In small and repeated doses they act as refrigerants and alteratives. They are useful in diseased liver, dropsical complaints, habitual constipation, hemorrhoids, determination of blood to the head, &c.

Order 2. Salt or Brine Waters.—The characteristic ingredient of these waters is chloride of sodium. Iodine or bromine, or both, have been recognised in some of them, and doubtless contribute somewhat to the medicinal effects.

Those salt waters whose chief ingredient is chloride of sodium, with which they are largely impregnated, are called *brine springs*. In England, the principal are Middlewich and Nantwich in Cheshire, Shirleywich in Staffordshire, and Droitwich in Worcestershire. The springs of Ashby-de-la-Zouch, in Leicestershire, contain, besides a large quantity of common salt, a considerable quantity of chloride of calcium. The Kreuznach and Salzhausen springs may be referred to in this division.

In the *saline thermal springs* chloride of sodium is the chief constituent, but it is associated with various other alkaline and earthy salts. The waters of Wiesbaden, Baden-Baden, and Bourbonne, are of this kind.

In some of the *saline cold springs* chloride of sodium is the leading ingredient, but associated with other salts; as the waters of the Cheltenham Old Well, of Leamington, and the spring at Pyrmont.

Some of the salt springs contain iron, and are in consequence called the *chalybeate salt springs;* as those of Kissingen (Ragozzibrunnen) and Homburg.

Bromine or iodine, or both, have been detected in the state of bromide and iodide in several of the salt springs, which, in consequence, have been denominated *bromide and iodine salt springs*. The English brine springs before mentioned, the Woodhall or Iodine Spa[1] near Horncastle in Leicestershire, and the Kreuznach brine springs, are of this kind.

Taken in large quantities, saline or brine waters are emetic and purgative. In small but continued doses they act as alteratives, and are supposed to stimulate the absorbent system. They have been principally celebrated in glandular enlargements, especially those which are of a scrofulous nature.

The water of the Dead Sea belongs to this order (see *ante*, p. 301).

Order 3. Calcareous Waters.—Those saline mineral springs whose predominating constituent is either sulphate or carbonate of lime, or both, are denominated calcareous waters.

The Bath, Bristol, and Buxton thermal waters are of this kind.

When taken internally their usual effects are stimulant (both to the circulation and the urinary and cutaneous secretions), alterative, and constipating; and are referable, in part, to the temperature of the water, in part to the saline constituents. Employed as baths, they are probably not much superior to common water heated to the proper temperature; but they have been much celebrated in the cure of rheumatism, chronic skin diseases, &c.

Bath water[2] is generally employed, both as a bath and as an internal medicine, in various chronic diseases admitting of, or requiring, the use of a gentle but continued stimulus; as chlorosis, hepatic affections, gout, rheumatism, lepra, &c. Diabetes has appeared to be benefited by it.

Buxton water, taken internally, has been found serviceable in disordered conditions of the digestive organs, consequent on high indulgence and intemperance; in calculous complaints; and in gout: employed externally, it has been principally celebrated in rheumatism.[3]

---

[1] See Granville's *Spas of England*, vol. ii. p. 104.

[2] For an account of the Bath waters, see—

William Oliver, *A Practical Dissertation on Bath Waters*, Bath, 1716.

Dr. Sutherland, *Natural History, Analysis, and General Virtues of the Bath and Bristol Waters*, London, 1763.

Dr. Falconer, *A Practical Dissertation on the Medicinal Effects of the Bath Waters*, Bath, 1790.

Dr. Gibbes, *A Treatise on the Bath Waters*, 1800; another edition, 1812.

Dr. E. Barlow, *Essay on the Bath Waters*, London.

Mr. Spry, *A Practical Treatise on the Bath Waters*, London, 1822.

[3] On the Buxton waters, see an anonymous *Treatise on the Nature and Virtues of Buxton Water*, London, 1761; Dr. G. Pearson's *Observations and Experiments for investigating the Chemical History of the Tepid Springs at Buxton*, London, 1784; Dr. James Denman's *Observations on the Effects of Buxton Water*, London, 1793; Mr. W. H. Robertson's *Medicinal Property of Buxton Water*, London; and Sir Charles Scudamore's work already quoted.

The water of Bristol Hot-well is taken in dyspeptic complaints and pulmonary consumption.

Order 4. Alkaline Waters.—The mineral waters denominated alkaline contain carbonate or bicarbonate of soda as their characteristic ingredient. The thermal springs of Teplitz[2] and Ems belong to this order. The waters of this order pass insensibly into, and are, therefore, closely related to, the waters of the preceding classes.

Springs which contain carbonate of soda, with a considerable excess of carbonic acid, are denominated *acidulo-alkaline*, and have been already noticed among the *acidulous* or *carbonated waters* (see *ante*, p. 309). The Vichy waters belong to this division (see *ante*, p. 265). The Selters waters are called *acidulo-alkaline muriatic*, on account of the common salt which they contain. The Carlsbad waters are also acidulo-alkaline, but on account of the sulphate of soda which they contain are called *warm alkaline glaubersalt waters* (see *ante*, p. 311). The *cold alkaline glaubersalt waters* before noticed (see *ante*, p. 311) are likewise acidulo-alkaline.

Those in which carbonate of soda is associated with protocarbonate of iron and excess of carbonic acid, have been referred to under the head of *acidulous carbonated chalybeates* (see *ante*, p. 307).

The only mineral waters in this country which contain carbonate of soda,[3] are those of Malvern,[4] in Worcestershire; and Ilkeston, in Derbyshire, near Nottingham; but the quantity in both cases is very small. The first, which is a very pure water, contains only 0·61 parts of the carbonate in 10,000 of the water, and the second 3·355 grains in an imperial gallon. For external use, the alkaline waters are principally valuable on account of their detergent qualities. When taken internally, they act on the urinary organs. They may be employed in calculous complaints connected with lithic acid diathesis, in gout, in dyspepsia, &c.

Order 5. Siliceous Waters.—Most mineral waters contain traces of silica, but some contain it in such abundance that they have been denominated siliceous. Thus, in the boiling springs of Geyser and Reikum, in Iceland, it amounts to nearly one-half of all the solid constituents. In these waters the silica is associated with (silicate of soda) sulphate of soda, and chloride of sodium.[5] I am unacquainted with their action on the body. It is probably similar to that of the alkaline waters.

For the following table of the fixed constituents of some of the most celebrated mineral waters, I am indebted to Dr. Gairdner's work:[6]—

---

[1] Consult Dr. Carrick's *Dissertation on the Chemical and Medical Properties of the British Hotwell Water*, Bristol, 1797.

[2] *Die Bäder von Teplitz*, von A. Reuss, Teplitz, 1835.

[3] The deep-well water of the London basin contains carbonate of soda (see *ante*, p. 299), but this is not included among mineral waters.

[4] For an account of the Malvern waters, see Dr. J. Wall's *Experiments and Observations on the Malvern Waters*, Worcester, 1763; Dr. M. Wall's *Malvern Waters*, Oxford, 1806; and Mr. Addison's *Dissertation on the Nature and Properties of Malvern Water*, London, 1828.

[5] See Dr. Black's analysis, in the *Transactions of the Royal Society of Edinburgh*, vol. iii.; also Faraday's, in Barrow's *Visit to Iceland*.

[6] *Essay on the Natural History, Origin, Composition, and Medicinal Effects of Mineral and Thermal Springs*, London, 1832.

FIXED CONSTITUENTS

ENTERING INTO THE COMPOSITION OF SOME OF THE MORE CELEBRATED

MINERAL SPRINGS.

Proportions in 10,000 *parts of Water.*

NOTE.—In reducing the analyses contained in this Table to a uniform measure, in order to render them susceptible of direct comparison with each other, I have assumed the old English gallon as = 58,338 grains; the wine pint = 7305 grs.; the imperial gallon = 70,000 grs.; and the German 16-ounce measure = 7368 grs.

The different salts have been reduced to their elementary constituents by Wollaston's scale of chemical equivalents.

THERMAL

NAME.	COUNTRY.	ACIDS.			BASES.			Oxide of Iron.	Silica.	SUM.	Authority and Date.	REMARKS.
		Carbonic.	Sulphuric.	Muriatic.	Soda.	Lime.	Magnesia.					
San Restituta	Ischia....	..	19·30	29·05	34·50	2·08	2·35	3·19	0·40	94·44	Giudice	Iron in the state of ferruginous alumina; sub-borate of soda, 2·79.
Gurgitello..............	Ditto	14·55	9·05	11·18	31·45	2·95	2·38	1·39	0·56	74·03	Ditto	Iron as in San Restituta.
Wiesbaden	Nassau ..	1·38	0·87	33·09	31·99	5·29	0·92	0·05	0·26	57·63	Kastner, 1823..	Free carbonic acid, 18·9; azote; potash, 0·83; alumina, 0·56; organic extract, 2·37.
Carlsbad Sprudel	Bohemia..	7·45	14·50	6·40	24·55	1·75	0·85	0·02	0·75	54·59	Berzelius, 1822	Minute traces of phosphoric and fluoric acids, strontian, alumina, and manganese.
St. Nectaire............	France ..	15·13	0·87	13·00	23·90	2·45	1·14	0·14	1·00	53·94	Berthier.	
Vichy..................	Ditto	15·81	1·55	0·72	24·47	0·27	..	0·01	..	42·75	Ditto.	
Ems (Kränchesquelle)..	Nassau ..	20·32	0·76	2·43	14·87	2·65	1·45	0·65	trace	42·74	Kastner, 1830..	Alumina, a trace; oxide of manganese, 2·42.
Olmitello	Ischia....	..	6·91	5·95	5·98	..	1·80	..	0·42	24·43	Giudice........	Potash, 2·73.
Bath (King's Bath)	England..	2·38	8·71	..	2·79	5·29	0·77	0·03	0·27	20·53	R. Phillips	The magnesia by Scudamore.
Mount d'Or............	France ..	2·86	0·36	2·05	4·74	0·90	0·28	0·10	2·10	13·39	Berthier.	
Geyser	Iceland ..	..	0·81	1·32	2·74	..	..	..	5·40	10·75	Black, 1791	Alumina, 0·48.
Chaudes Aigues........	France ..	3·07	..	0·86	3·12	1·01	9·59	0·15	1·16	9·96	Berthier.	
Rycum (Reikum)	Ic eland ..	..	0·71	1·55	2·43	..	..	..	3·73	8·47	Black, 1791	Alumina, 0·05.
Bristol Hot Well	England..	1·02	2·25	1·17	1·17	0·82	0·43	..	..	8·19	Carrick, 1797 ..	Free carbonic acid, 12·99.
Schlangenbad..........	Nassau ..	3·50	..	0·80	2·42	0·90	0·53	..	..	6·96	Kastner, 1823 ..	Free carbonic acid, 6·0.
Teplitz	Bohemia .	1·89	0·40	0·29	2·62	0·36	0·18	0·03	0·42	6·24	Berzelius, 1822..	Phosphoric acid potash, alumina.
Buxton	England..	0·78	0·06	0·28	0·19	1·04	6·04	..	..	2·70	Scudamore, 1820	Azote, 2·01, by Pearson.

COLD.												
Vicar's Bridge	Scotland..	..	203·00	0·18	0·16	2·56	13·2	103·00	..	563·10	Connell, 1831 ..	Potash, a trace.
Püllnas	Bohemia..	4·63	182·83	17·20	75·00	20·38	45·45	..	0·24	341·1	Struve	Potash, 3·55.
Saidschutz	Ditto	4·81	97·43	1·43	14·20	6·02	41·92	trace	0·16	177·4	Ditto..........	Nitric acid, 7·75; phosphoric acid; potash, 3·61; strontia, 0·03; alumina; oxide of manganese.
Leamington (Royal Pump)	England..	..	20·80	71·90	57·90	12·00	4·95	1·09	..	153·9	Thomson, 1830	Traces of iodine and bromine, by Daubeny.
Harrowgate (old sulphur well)........	Ditto	1·20	0·80	76·83	60·50	4·47	1·94	..	..	145·4	Scudamore, 1819.	
Airthrey (first spring) ..	Scotland..	..	4·25	76·46	32·10	32·50	0·31	..	..	127·4	Thomson, 1828.	
Cheltenham (old well) ..	England..	..	11·05	50·65	45·80	4·26	1·22	trace	..	111·6	Scudamore, 1819	Traces of iodine, by Daubeny.
Hartfell aluminous chalybeate	Scotland..	..	63·23	..	..	..	..	40·00	..	101·3	Thomson, 1828..	Alumina, 5·10.
Isle of Wight	England..	..	48·58	2·95	6·85	5·68	0·82	14·60	0·96	88·21	Marcet	Alumina, 7·77.
Marienbad (Ferdinandsquelle)	Bohemia .	9·52	27·60	9·50	38·05	2·87	1·67	0·12	0·50	86·18	Steinmann, 1820	Phosphoric acid, lithion, strontian, alumina, manganese, by Berzelius.
Dunblane (north spring)	Scotland..	0·30	2·23	33·55	15·30	14·04	..	0·23	..	63·21	Murray, 1814.	
Vals	France ..	22·48	0·29	3·00	33·34	1·60	0·22	0·06	0·45	61·17	Berthier.	
Bilin	Bohemia .	20·51	3·40	1·44	28·47	2·47	1·60	0·10	..	57·46	Reuss, 1788.	
Franzensbad (Franzensbrunn)	Ditto	5·44	18·50	6·21	26·70	1·26	..	0·37	0·48	55·80	Tromsdorff, 1820	Phosphoric acid, lithion, strontian, alumina, manganese, by Berzelius.
Pitcaithly	Scotland..	0·30	0·73	27·20	8·50	13·99	..	trace	trace	46·95	Murray, 1814.	
Roisdorf..............	Rhenish Prussia..	6·76	2·50	9·70	16·00	1·78	1·33	0·07	0·21	38·11	Bischoff, 1826 ..	Potash.
Epsom	England..	2·50	14·80	4·21	5·64	11·80	..	.	..	37·94	Daubeny, 1830..	Trace of bromine.
Selters (Nieder)	Nassau ..	5·37	0·18	9·92	16·06	1·37	1·00	0·12	0·38	84·60	Bischoff, 1826 ..	Phosphoric acid, 0·19.
Fachingen..............	Ditto	11·49	0·12	2·63	15·63	1·83	1·09	0·07	0·11	32·98	Ditto	Phosphoric acid, 0·005.
Soden..................	Ditto	3·35	0·07	12·30	10·72	4·08	0·06	0·08	0·06	30·89	Meyer, 1820.	
Moffat	Scotland..	..	2·80	13·60	12·75	0·68	0·26	..	..	30·03	Thomson, 1828.	
Pyrmont	Germany .	4·03	9·83	0·99	1·29	85·6	1·98	0·36	0.68	27·89	Struve	Phosphoric acid, potash, strontian, manganese.
Marienfels	Nassau ..	4·83	0·18	1·88	3·42	2·20	1·27	0·10	trace	15·99	Kastner	Potash, 1·19; strontian; manganese; phosphoric acid.
Strathpeffer (pump-room)	Scotland..	..	9·32	2·17	6·18	2·33	0·30	..	..	15·36	Thomson, 1828..	Potash?
Geilnau................	Nassau ..	6·00	0·07	3·18	5·08	1·46	1·40	0·13	0·14	14·66	Bischoff, 1826 ..	Phosphoric acid, 0·19.
Weilbach	Ditto	3·61	0·81	1·31	4·60	1·55	2·05	..	..	14·40	Creve, 1810	Sulphur-resin, 0·48.
Hartfell Spa............	Scotland..	..	2·76	3·05	..	1·30	..	2·49	..	9·95	Thomson, 1828..	Alumina, a trace.
Langenschwalbach Weinbrnnn	Nassau ..	3·84	0·12	0·12	0·34	1·55	1·95	0·67	trace	8·58	Kastner, 1829..	Potash, lithion, iodine, strontian, alumina, manganese, phosphoric acid.
Spa....................	Belgium..	6·63	0·51	0·33	0·92	0·74	0·72	7·90	0·68	5·92	Struve	Phosphoric acid; potash, 0·58; manganese.
Carlsbad (Sauerling)....	Bohemia..	0·28	0·13	0·07	0·28	0·16	0·06	0·06	0·61	1·42	Berzelius, 1822	Phosphoric acid, fluate of lime, alumina, oxide of manganese.
Tunbridge	England..	0·20	0·14	0·29	0·19	0·39	0·02	0·38	0·07	1·32	Scudamore, 1816	Oxide of manganese.
Malvern	Ditto	0·32	0·14	0·08	0·55	0·03	0·02	0·04	..	1·01	Phillip, 1805.	

For further details respecting mineral waters in general, the reader is referred to the following works:—

Dr. J. Rutty.—*Methodical Synopsis of Mineral Waters*, Lond. 1757.
Dr. W. Munro—*Treatise on Mineral Waters*, Lond. 1770.
Dr. W. Saunders—*Treatise on the Chemical History and Medical Powers of some of the most celebrated Mineral Waters*, Lond. 1800.
G. F. L. Fuchs—*Systematische Beschreibung aller Gesundbrunnen und Bäder der bekannten Länder, vorzüglich Deutschlands, sowohl nach ihrer physisch-chemischen Beschaffenheit*, 2 Bd. Jena, 1801.
C. F. Mosch—*Die Bäder und Heilbrunnen Deutschlands und der Schweiz*, Leipzig, 1819.
Alibert—*Précis historique sur les Eaux Minérales*, Paris, 1826; also in his *Nouveaux Elémens de Thérapeutique*, 3me tom. 5me éd. Paris, 1826.
C. Stucke—*Abhandlung von den Mineralquellen in Allgemeinen, und Versuch einer Zusammenstellung von* 880 *der bekannteren Mineralquellen und Salinen Deutschlands, der Schweitz und einiger angrenzender Länder, mit analytischen Tabellen worin etwa* 250 *chemische Analysen von Mineralquellen angegeben sind.* Nebst 1, Charte von Deutschlands Mineralquellen. Cöln. 1831.
E. Osann—*Physikalisch-medicinische Darstellung der bekannten Heilquellen der vorzüglichsten Länder Europa's*, Berlin, 1er Theil, 1829.—2er Theil, 1832.—2te Aufl. 1839.
L. F. v. Zeidlitz—*Balneographisch-statist.-histor. Hand- und Wörterbuch, oder die Heilquellen und Gesundbrunnen Deutschlands*, &c. Leipzig, 1834.
Sir C. Scudamore—*On the Properties of the Mineral Waters of England*, 8vo. 2d edit. 1833.
Dr. T. Thomson—*Cyclopædia of Practical Medicine*, art. *Waters, Mineral*, vol. iv. Lond. 1835.
Mr. Lee—*An Account of the most frequented Watering Places on the Continent*, Lond. 1836.
Patissier et Bourtron-Charlard—*Manuel des Eaux Minérales Naturelles*, 2nde édit. Paris, 1837.
Dr. A. B. Granville—*The Spas of Germany*, Lond. 1837.—2d edit. 1838.
G. W. Schwartze—*Allgemeine und specielle Heilquellenlehre*, Leipzig, 1839.
A. Vetter—*Theoretisch-praktisches Handbuch der Heilquellenlehre.* Berl. 1839, 2te Ausg. 1845.
J. F. Simon—*Die Heilquellen Europa's, mit vorzügl. Berücksichtig. ihrer chem. Zusammensetzung nach ihrem physikal. u. Med. Verhalten dargestellt.* Berlin, 1839.
H. C. W. Hufeland—*Prakt. Uebersicht der vorzügl. Heilquellen. Teutschlands nach eigenen Erfahrungen.* Herausg. u. ergänzt von. E. Osann. 4. Aufl. Berlin, 1840.
Mr. Lee—*Principal Baths of Germany*, 1840.
Dr. J. Johnson—*Pilgrimage to the Spas*, Lond. 1841.
Dr. A. B. Granville—*The Spas of England*, Northern, Midland, and Southern, 1841.
Sir A. Downie—*On the Efficacy of Mineral Waters in the Cure of Chronic Complaints*, 12mo. 1841.

ARTIFICIAL MINERAL WATERS.—In this country the demand for artificial mineral waters has considerably increased of late years, but it is unnecessary in this place to enter into any details respecting their manufacture. Those who desire information on this subject will find it in the works of Soubeiran[1] and Guibourt.[2] Under CARBONIC ACID the reader will find a description of one form of apparatus used in this country.[3]

---

[1] *Nouveau Traité de Pharmacie*, t. ii. 2nde édit. Paris, 1840.

[2] *Pharmacopée Raisonnée, ou Traité de Pharmacie pratique et théorique*, par N. E. Henry et G. Guibourt, 3ème édition, revue et considérablement augmentée par N. J. B. G. Guibourt, Paris, 1841. The *Codex Pharmacopée Française*, also, contains formulæ for the preparation of artificial mineral waters.

[3] The manufacture of *Sodaic* and *Magnesian Waters* will be described hereafter.

4. Hydrogenii Binoxydum.—Binoxide of Hydrogen.

Formula HO^2. *Equivalent Weight* 17.

Peroxide of Hydrogen; Oxygenated Water.—Discovered by Thenard in 1818. Its medicinal qualities are at present unknown; but, from its remarkable chemical properties, some persons have imagined that it must be a powerful therapeutic agent. The Dutch Society of Sciences at Haarlem offered a prize in 1830 for an essay on its chemical and medicinal properties, but I am not aware that the adjudication has taken place. Thenard ascertained that fibrine and the animal tissues decompose the binoxide with the evolution of oxygen. It whitens the epidermis and the epithelium of the tongue, causing a pricking sensation, and it thickens the saliva. It must not be confounded with either *aqua oxygenii* (see *ante*, p. 277) or the *aqua nitrogenii protoxydii.*

ORDER III. CARBON AND CARBONIC ACID.

5. CARBONIUM.—CARBON.

Symbol C. *Equivalent Weight* 6.[1] *Equivalent Volume of Carbon Vapour* (?) 1 or

HISTORY.—The term *carbon* (from *carbo, ōnis*, coal) was first employed by Morveau, Lavoisier, and Berthollet, to designate the pure matter of charcoal. To the second of these chemists we are indebted for demonstrating, that by combustion in oxygen gas the diamond and charcoal yield the same product—namely, carbonic acid gas.

NATURAL HISTORY.—Carbon is found in both kingdoms of nature:

a. IN THE INORGANISED KINGDOM.—When pure and crystallised, it constitutes the diamond, which Sir D. Brewster[2] suspects to be of vegetable origin; but a specimen, described by Mr. Heuland,[3] was found in a primary rock. Plumbago and anthracite consist principally of carbon. The bituminous substances (as coal, petroleum, naphtha, &c.) also contain it. These are admitted by geologists to be of vegetable origin. Carburetted hydrogen is evolved from coal strata, marshy places, stagnant waters, &c. Carbonic acid is found either in the free state, as in the atmosphere, in mineral waters evolved from the earth in old volcanic countries, &c., or combined with metallic oxides, in the form of the carbonate of lime, iron, &c. It is remarkable that carbon is rare among the older rocks.[4]

β. IN THE ORGANISED KINGDOM.—Carbon is an essential constituent of all organised beings, both vegetable and animal.

PROPERTIES.—Carbon is a solid, odourless, tasteless substance, neither fusible (?) nor volatile; combustible in oxygen gas, and yielding carbonic acid gas. The other properties of carbon are so varied, that chemists are obliged to admit distinct varieties of this substance: the principal are the *diamond, plumbago,* and *charcoal* (animal and vegetable). Of these, the two latter only require consideration in this work.

[Carbon, like oxygen, is now considered to assume the allotropic form, and to show varying chemical reactions in consequence. The diamond and plumbago must be regarded as merely allotropic forms of ordinary carbon.—ED.]

---

[1] [There is a considerable difference of opinion among chemists respecting the equivalent number and volume of carbon vapour. In a work specially devoted to Materia Medica we have not thought it advisable to make any change.—ED.]

[2] *Edinb. Philosophical Journal*, vol. iii. p. 98; and *Philosophical Magazine*, vol. i. p. 147, 1827.

[3] *Geological Transactions*, 2d series, i. 419.

[4] De la Beche, *Researches in Theoretical Geology*, p. 32, London, 1834.

1. Plumbago vel Graphites.—Graphite or Black Lead.

HISTORY.—Plumbago (so called from its resemblance to *plumbum* or lead,) or graphite (from γράφω, *I write*, on account of its use as a writing material), was probably known to the ancients; but it was first accurately distinguished from other bodies with which it had been previously confounded, especially with molybdena (*bisulphide of molybdenum*), by Scheele,[1] in 1779.

The terms *plumbago*, *plumbum nigrum*, and *molybdæna*, met with in Pliny,[2] do not apply to graphite.

NATURAL HISTORY.—It is found in various parts of the world; chiefly in primitive rocks and the coal formations. It occurs at Borrowdale in Cumberland, in various parts of the continent of Europe (Bavaria, Bohemia, Spain, &c.), in Ceylon, and in the United States of America. A very pure graphite is found near Bustletown in Pennsylvania.

Graphite is found either crystallized or compact. Crystallized graphite (*graphites crystallinus*) may be foliated, scaly, or radiated, : its forms are thin six-sided tables belonging to the rhombohedric system. Compact graphite (*graphites solidus*) occurs either massive or disseminated.

Borrowdale plumbago is of fine quality. It is brought to London, and sold by auction at a public-house in Essex-street, Strand, on the first Monday in every month.[3] The best quality usually sells for two guineas or more per pound, and is employed for making pencils.

Spanish Plumbago is imported from Malaga, It is probably obtained from the mountain of Mora, near Marbella, in Andalusia. It is sometimes of superior quality.

Ceylon or *East India plumbago* is another sort which is extensively imported. Its quality is inferior.

German plumbago is imported from Hamburgh. It is of inferior quality, and is said to be the produce of Bohemia. The so-called *Mexican black lead* is imported from Hamburgh.[4]

PROPERTIES.—As found in commerce, it is usually in kidney-shaped masses. Its colour is iron or steel-grey, with a metallic lustre. It has a greasy feel, and writes easily on paper. Its specific gravity is 2·08 to 2·45.

Characteristics.—It is known to be carbon by its yielding carbonic acid by combustion in oxygen gas. When burned, it usually leaves a residuum of silica and red oxide of iron. It is infusible before the blow-pipe. Its physical properties distinguish it from most other varieties of carbon. Some kinds of coal-gas charcoal (*artificial graphite*) closely resemble it. Of non-carbonaceous substances, molybdena (*bisulphide of molybdenum*) is the only substance that can be confounded with it in external appearance.

---

[1] *Essays*, p. 246.

[2] *Historia Naturalis*, lib. xxxiv. cap. 47, 50, and 53, ed. Valp.

[3] *London Medical Gazette*, vol. xviii. p. 267.

[4] [In reference to the sources of plumbago, we find the following among some notes left by the late Dr. Pereira:—" Visited the Borrowdale lead mine; was told no plumbago had been sent to market for three years; now engaged in running a level in order to find the vein; not been successful at present; the old workings are discontinued" (July 1849). In a note to Dr. Pereira, from a correspondent, we also find it stated that " Mexican black lead is much adulterated; sand, black clay, powdered black lead crucibles, and inferior qualities of lead, being used for the purpose. The finest plumbago is called pencil lead; the inferior, Naples lustre, Mexican jet, &c. Spanish plumbago is scarcely in the market."]

PURITY.—Graphite usually contains traces of iron and silica. When of good quality it is free from all visible impurities (sand, stones, &c.) When heated before the blow-pipe, it should be infusible, and not evolve any odorous vapour or smoke: its freedom from metallic sulphurets (as of antimony and lead) is thereby shown. It is insoluble in alkalies and acids. Hydrochloric acid boiled with it should dissolve only some minute portions of iron; and the filtered acid liquid should yield no precipitate on the addition of carbonate of ammonia, and no change of colour when sulphuretted hydrogen is added to it.

The powder sold in the shops under the name of *black lead*, for polishing iron grates, &c. is an adulterated article, and is unfit for medicinal purposes. It is usually prepared by reducing the quality of the so-called Mexican plumbago (German plumbago) by grinding it with sand, old black lead crucibles, a substance called Bideford black (which I am informed is a kind of black clay found near Bideford in Devonshire), and an inferior plumbago called common lead, seconds, or German gunpowder (from its being granulated like gunpowder). When reduced, it forms *Naples lustre, Mexican jet, black lead*, &c.

Wackenroder[1] has signalised the existence of a commercial graphite, of which three-fourths were sulphuret of antimony.

For ordinary purposes, powdered graphite is purified by boiling it with nitro-muriatic acid, and then washing and drying it.

Dumas and Stas[2] purified it for analysis by heating it to redness with caustic potash, then washing it with water, boiling with nitric acid and nitro-muriatic acid to extract iron and bases, washing, drying, and then exposing it, at a white heat, to a stream of dry chlorine gas, by which chloride of iron and chloride of silicon were volatilised. When thus purified, it contained merely a trace of silica.

COMPOSITION.—It consists essentially of carbon, but is usually mixed with variable proportions of silica, iron, and other substances. The following are analyses of three varieties by Vanuxen:[3]—

	Borrowdale (*pure*).	*Borrowdale* (*impure.*)	*Bustletown* (*pure*).
Carbon	88·37	61·27	95·4
Water	1·23	5·33	0·6
Silica	5.10	10·10	2·6
Alumina	1·00	3·20	0·0
Oxides of Iron, Manganese, &c.	3·60	20·00	1·4
Plumbago	99·30	99·90	100·0

I suspect, however, that the finest varieties of the Borrowdale graphite contain a smaller quantity of foreign matter than is here stated. Graphite has been recently analysed by Dr. R. F. Marchand,[4] who states that 1·4580 *gramme* of native graphite left a residue of pure white silica, without a trace of oxide of iron, weighing only 0·0075.

On the erroneous supposition that the carbon was chemically combined with iron, graphite was formerly called *carburet* or *percarburet of iron*. From some observations of Schrader, however, it would appear that the iron is in combination with titanic acid.

PHYSIOLOGICAL EFFECTS.—Various properties have been assigned to it; but further evidence is wanting to establish its action on the body. Richter[5] says it alters, in some way, the lymphatic secretion and the condition of the skin; and, after some days' use, causes increased secretion of urine, with difficulty in passing it.

---

[1] *Pharmaceutisches Central-Blatt für* 1838, p. 524.

[2] *Ann. Chim. et Physiq.* 3ème sér. i. p. 1–54.

[3] Silliman's *Journal*, vol. x. p. 105.

[4] *Proceedings of the Chemical Society*, No. i. p. 12, 1841.

[5] *Ausführliche Arzneimittellehre*, Bd. iii. p. 486, Berlin, 1828.

Uses.—It has been employed both externally and internally in chronic diseases of the skin (as herpes). When used externally, it is employed in the form of ointment (*Unguentum plumbaginis*), composed of from one to six drachms of plumbago to an ounce of lard. Internally the dose is ten or twelve grains to a drachm, or more.

2. Carbo Ligni.—Wood Charcoal.

Carbo e ligno igne præparatus, *L.* Carbo ligni, *E. D.*

History.—Wood charcoal must have been familiar to man from the most remote period of antiquity, and was probably known to the first inhabitants of the globe. For an account of the ancient method of procuring it, I must refer the reader to the works of Theophrastus (cap x.) and Pliny.[1]

Natural History.—Wood charcoal is always an artificial product. Some samples of Bovey coal have very much the appearance of wood charcoal, but are readily distinguished by their containing hydrogen, in consequence of which they burn with a yellow flame. Moreover they are not good conductors of galvanic electricity.[2]

Preparation.—Ordinary wood charcoal is prepared, on the large scale, for the purposes of fuel, by burning billet-wood (oak, beech, hazel, and sometimes willow), piled in a conical heap, covered with turf and sand, to prevent the access of atmospheric air, a few holes being left near the bottom and one at the top to occasion a draught. The heap is then set fire to, and when the flame has pervaded the whole mass, the holes are closed. When cooled, the billets are found converted into charcoal. For an account of the mode of arranging the wood in heaps, consult Dumas.[3]

The charcoal used in the manufacture of gunpowder is prepared by the distillation of wood in cast iron cylinders, set horizontally (or nearly so) in brick work, over a furnace. The charge is introduced at the front, and the opening is then perfectly secured by an iron door and bar, well luted. The back part of each cylinder is perforated by two pipes, one above the other, and bent downwards into tubs containing water. The tar flows out by the lower pipe, and the pyroligneous acid by the upper one, and condenses in the receiver (the tub). The smoke and vapours escape into the air. When sufficiently burnt, the charcoal is raked out into iron boxes, which are immediately covered, to exclude the air.[4] At the Waltham Abbey mills, charcoal is prepared from the Dogwood (*Cornus sanguinea*) the Alder (*Alnus glutinosa*), and the Willow (*Salix*). The Dogwood charcoal (which occasions a peculiar ringing sound when it falls on stones) is used for rifle powder: the other kinds for cannon and musket powder. Lieut.-Col. Moody tells me that the Dutch White Willow (*Salix Russelliana?*) is the best kind of willow for charcoal, but that the Huntingdon Willow is also a good one. (See *Acidum Aceticum.*)

Box wood charcoal for galvanic purposes is prepared by putting prismatic pieces of box wood, about an inch long and half an inch thick, into a crucible, covering them with dry sand, and exposing them to a red heat for about an hour.

Properties.—Wood charcoal is black, odourless, and insipid. It has the

---

Hist. Nat. lib. xvi. cap. 7.

[2] Kidd's *Outlines of Mineralogy*, vol. ii. p. 47.

[3] *Traité de Chimie appliquée aux Arts*, t. i. p. 561.

[4] For some further details, consult Mr. Wilkinson's work on the *Engines of War*, London, 1841

texture of the wood from which it has been obtained. It is brittle, and may be easily pulverised, especially when hot. Though a very bad conductor of heat, it is an excellent conductor of electricity. It is insoluble, infusible, and incapable of volatilization. Its specific gravity varies according to the substance from which it has been obtained. A remarkable property possessed by it is that of abstracting certain substances (such as hydrosulphuric acid, organic colouring principles, various odorous matters, &c.) from liquids in which they are dissolved, or through which they are diffused. Another curious quality is that of condensing within its pores a certain quantity of any gas with which it may be placed in contact. Thus one volume of boxwood charcoal absorbs 1·75 volumes only of hydrogen gas, but 90 volumes of ammoniacal gas. Some of the properties now mentioned (as that of decolorising) are possessed, in a more eminent degree, by animal charcoal.

Characteristics.—By combustion in oxygen gas, wood charcoal yields carbonic acid gas,—a property by which it is shown to consist of carbon. Its texture and appearance, as well as the nature of the ashes which it leaves behind when burnt, serve to distinguish it from other forms of carbon. (See *Animal* Charcoal).

COMPOSITION.—The following is the composition of charcoal obtained from different woods, according to the experiments of Berthier:[1]—

	Poplar.	Maple.	Ash.	Fir.	Alder.	Birch.	Oak.	Hazel.
Carbon	85·6	85·2	83·2	90·3	90·2	88·1	88·0	87·7
Calcined Ashes......	1·0	1·0	1·8	2·2	1·8	1·9	2·0	2·0
Volatile Matters ...	13·4	13·8	15·0	7·5	8·0	10·0	10·0	10·3
Charcoal	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0

Wood ashes consist of soluble alkaline salts and of insoluble matters. The alkaline salts have for their base potassium and sodium: they contain (or yield) carbonic, sulphuric, and hydrochloric acids, a little silica, and sometimes a trace of phosphoric acid. The insoluble matters contain carbonic and phosphoric acids, silica, lime, magnesia, and the oxides of iron and manganese. The quantity of carbonic acid is never sufficient to saturate both the alkalies and the earths, in consequence of the heat having expelled carbonic acid from the earthy carbonates. (See *Potassæ Carbonas.*)

PHYSIOLOGICAL EFFECTS.—Wood charcoal I believe to be an inert substance, both with respect to animals and vegetables. Burdin[2] gave a pound of it daily without producing any other effect than that of blackening the stools. A variety of properties and virtues have, however, been ascribed to it,—as I believe, without foundation: thus it has been termed anodyne, emmenagogue, tonic, purgative, &c. In the French edition of Hahnemann's Materia Medica,[3] no less than thirty-five pages are occupied with the enumeration of the symptoms produced by one-millionth of a grain of this substance!!

USES.—In this country, charcoal is used as a therapeutic agent, principally as a disinfectant and antiseptic, to absorb the fetid odour evolved by gangrenous and phagedenic ulcers. For this purpose it may be used in the form of powder or of poultice. Its disinfecting and antiseptic powers, however, are much inferior to those of chlorine, or of the chlorides [hypochlorites] of lime and soda.

---

[1] *Traité des Essais par la Voie sèche*, t. i. p. 286, Paris, 1834.

[2] *Dict. de Mat. Méd.* par MM. Mérat et De Lens, t. ii. art. *Carbone*.

[3] *Traité de Matière Médicale*, par S. Hahnemann, traduite par A. J. L. Jourdan, Paris, 1834.

As a *tooth-powder* it is a valuable agent, freeing the teeth from the foreign matters which cover them, and at the same time counteracting the unpleasant smell of the breath arising from decayed teeth or disordered stomach; but it is apt to lodge in the space between the gum and tooth, forming an unsightly livid circle (see *ante*, p. 159). Brachet[1] states that it checks caries of the teeth. *Areca-nut charcoal* is a favourite variety for tooth-powders. Its fancied superiority is ascribed to the extreme hardness of its particles.

Internally, charcoal has been exhibited in various affections of the alimentary canal, such as dyspepsia, cardialgia, diarrhœa, cholera, and dysentery. The beneficial effects said to have been produced in these cases can only be referred to the action of charcoal on the secretions of the bowels; an explanation apparently supported by Dr. Chapman's statement, that in dysentery, when the stools are highly acrid and offensive, charcoal entirely divests them of the bad smell and acrimony. In consequence of the advantage said to have been obtained by Dr. Calcagno, of Sicily, by the use of charcoal in intermittents, it was tried by Dr. Calvert, physician to the British forces at Palermo, and with success.[2] In this country, however, I believe it is never resorted to in ague by medical practitioners. Dr. Daniel, of Savannah, has recommended it in obstinate constipation, and in the nausea and confinement of the bowels which frequently attend pregnancy. It has also been used in various other diseases, but experience has not confirmed its efficacy.

ADMINISTRATION.—The dose of charcoal, as ordered by different writers, varies from ten grains to a tablespoonful or more.

CATAPLASMA CARBONIS, L.; *Charcoal Poultice.* (Take of Boiling Water, f℥x.; of Bread, ℥ij.; of Linseed, powdered, ʒx.; of Powdered Charcoal, ʒiij. Macerate the bread in the water near the fire for a short time, then mix and add the linseed by degrees, stirring so that a poultice be made. To this mix in two drachms of the charcoal, and sprinkle the remainder over the surface.)—The charcoal poultice is applied to foul, unhealthy, and gangrenous ulcers, to destroy their fetor and improve their appearance. As an antiseptic, however, it is inferior to the chlorides [hypochlorites] of lime and soda.

3. Carbo Animalis.—Animal Charcoal.

(Carbo e sanguine bovino igne præparatus, *L.* Carbo animalis, *E. D.*)

HISTORY.—This substance must have been known from the most ancient times. The kind usually met with in the shops is prepared from bones, and is termed *bone black* or *animal black*. It is sometimes sold as *ivory black* (*ebur ustum nigrum*).

PREPARATION.—Animal charcoal is extensively manufactured from bones for the use of sugar-refiners; and during the process an ammoniacal liquor (called *bone spirit*) is obtained as a secondary product. The operation is thus conducted:—

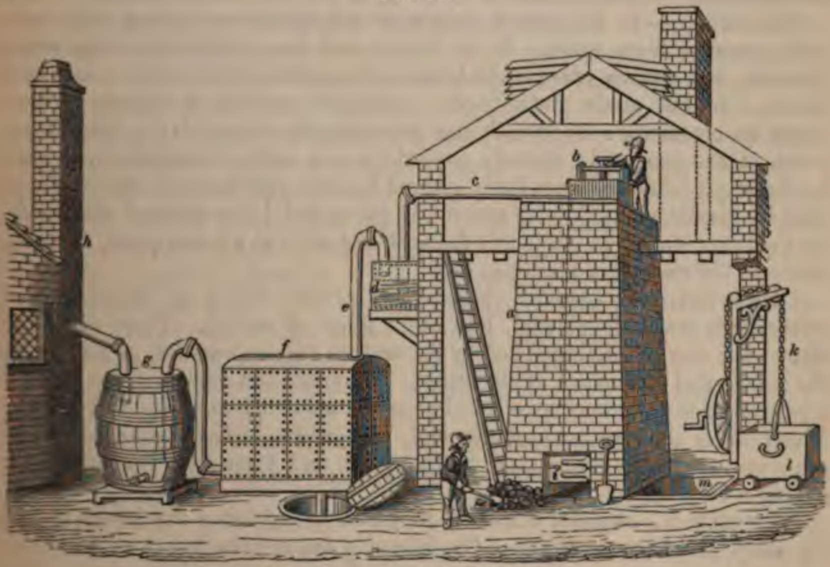
Bones are first boiled to remove the fatty matter which is used in soap-making. The larger and finer pieces are then selected for the manufacture of buttons, handles of knives and tooth-brushes, &c.; while the smaller and refuse portions are sold as manure. The remainder is submitted to distillation.

---

[1] *Considérations sur l'Usage du Carbone en Médecine*, Paris, 1803.
[2] *Edinburgh Medical and Surgical Journal*, vol. x. p. 13.

The stills or retorts are sometimes made of cast iron, and in shape and size resemble those used at gas-works. Formerly they were placed horizontally in the furnace,[1] and the volatile matters were conveyed away by a pipe opening into the ends of the retorts. To facilitate the speedy removal of the charcoal, they are sometimes placed obliquely in the furnace: the bones are introduced at the upper end, and the charcoal is removed from the lower end;—while the volatile matters are conveyed away by a side pipe. But these retorts are considered inferior to the vertical ones, on account of the facility and speed with which the latter can be charged and discharged. The vertical stills or retorts are made either of cast iron or of Welsh bricks; the latter, I am informed, are preferable. In a large manufactory of animal charcoal in this metropolis, the shape of the retort is that of a right rectangular prism; its height being twenty feet, its length about three feet, and its breadth two feet. It is closed at the top by a movable iron plate, secured by a screw bolt. It is closed below by a double trapdoor opening underground. Around the retort is a furnace of brickwork, whose shape is that of a truncated pyramid.

FIG. 48.



Manufactory of Animal Charcoal.

a. Furnace inclosing the retort.
b. Top of the retort.
c. Pipe to convey away the volatile products.
d. Water cistern, through which the volatile matter passes.
e. Pipe leading to
f. The iron receiver (an old steam boiler), communicating with a reservoir cistern under ground.
g. Second receiver.
h. Chimney into which the residual vapour passes.
i. Furnace door.
k. Crane.
l. Canister to receive the charcoal.
m. Steps leading to the lower end of the retort.

---

[1] See Ure's *Dictionary of Arts and Manufactures*, p. 1081, figs. 954 and 955, London, 1839.

The bones are introduced at the upper end of the retort (*b*). The volatile products are conveyed away by the iron pipe (*c*). After passing through the cistern (*d*) they are conveyed to a series of receivers (*f* and *g*), where the brown ammoniacal liquor (*bone spirit*) and the empyreumatic oil (*animal oil*) are deposited. The non-condensible portion is a fetid inflammable gas: this, after passing through water contained in the second receiver, is conveyed into a chimney, or is burned. The solid residue in the retort is removed, while red-hot, through the lower and underground end of the retort, into wrought-iron canisters (*l*), which are instantly closed by iron covers, luted to make them air-tight, and then raised to the surface by a crane (*k*). When cold it is ground, and sold as *animal, bone,* or *ivory black.*

The volatile products of this operation are easily accounted for. When bones are heated, their cartilaginous or gelatinous portion undergoes decomposition, and its elements enter into new combinations. Some of the oxygen and hydrogen unite to form *water*. Carbon and oxygen, combining in different proportions, furnish *carbonic oxide* and *acid*. Carbon with hydrogen forms *carbohydrogen;* while nitrogen uniting with hydrogen produces *ammonia*, which, with some carbonic acid, forms *carbonate of ammonia*. The *empyreumatic* or *animal oil* consists of carbon, hydrogen, and oxygen, with probably some nitrogen.

PROPERTIES.—In its general properties animal charcoal agrees with charcoal procured from wood. It is denser and less combustible than wood charcoal, but greatly exceeds the latter in its power of destroying colour and odour. In the crude state (*carbo animalis crudus*) it occurs in four forms in commerce: unground, and retaining the shape of the bones from which it was procured; coarsely ground (*grain animal charcoal*), as used by the sugar-refiners; more finely ground (*coarse grit animal charcoal*), as used by distillers; and finely ground or pulverised (*fine animal charcoal*). In the latter state it is frequently damped, and sold, at a lower price, as *ivory black* to the makers of blacking, &c.

Characteristics.—Animal charcoal yields, when burnt in oxygen gas or atmospheric air, carbonic acid, like other forms of carbon. From vegetable charcoal it may be distinguished by its texture and appearance, as well as by the nature and properties of its ashes. To obtain the ashes for examination a portion of the charcoal should be burned on a red-hot iron into white ashes. Wood ashes dissolve in sulphuric acid, and yield a bitterish solution: bone ashes are very sparingly affected by that acid, and form with it a compound having a very different taste.

COMPOSITION.—Animal charcoal, prepared by calcining the bones of the ox, sheep, and horse, consists of the following ingredients:[1]—

Phosphate of lime Carbonate of lime	88·0
Charcoal	10·0
Carburet or siliciuret of iron	2·0
Sulphuret of calcium or iron	traces
Common Bone Black	100·0

The proportion of charcoal here stated is certainly small. Dr. Christison states that he has found, in the animal black of this country, usually about 20 per cent. of charcoal. When bone black is calcined in the open air, the carbon is burnt off, and a whitish residue is obtained, called *bone ash*. (See *Calcis Subphosphas*.)

---

[1] Dumas, *Traité de Chimie*, t. i. p. 450, Paris, 1828.

For the ordinary purposes of the arts, as sugar-refining, crude animal charcoal answers very well, because the earthy salts in no way affect the process. But in various pharmaceutical operations the presence of phosphate and carbonate of lime would preclude its use, on account of the free acid in the liquids to be decolorised. Hence the necessity of the purification of animal charcoal. (See *Carbo animalis purificatus*, p. 326.)

Animal charcoal, when deprived of its saline matters, usually contains traces of nitrogen. Döbereiner, indeed, supposed it to be a kind of subnitruret of carbon, composed of one equivalent or 14 parts of nitrogen, and six equivalents or 36 parts of carbon. Bussy, however, has shown, that though animal charcoal retains its nitrogen with considerable obstinacy, yet that the latter may be separated by heat.

PHYSIOLOGICAL EFFECTS.—The remarks already made in reference to the physiological effects of wood charcoal apply equally well to animal charcoal.

USES.—The principal use of animal charcoal is as a decolorising agent in various pharmaceutical processes, as in the refining of sugar, the preparation of disulphate of quina, hydrochlorate of morphia, veratria, &c. The superior value of animal to vegetable charcoal for this purpose is usually referred to the minute separation of the carbonaceous particles effected by the presence of other matters, as of phosphate of lime, when bones are employed. Carbonate of potash is better for this purpose than phosphate of lime. The property possessed by minute particles of charcoal, of abstracting colouring matter from liquids, depends, probably, on some chemical affinities existing between carbon and colouring matter. It has been stated that charcoal which has been once used cannot have its decolorising property restored by a fresh ignition, unless it be mixed with some inorganic substance. This, however, is an error. The animal charcoal which has been used in sugar-refining is returned to the maker to be freshly ignited, and is then employed again, and this process of re-igniting is repeated many times, without any loss of decolorising power. [Animal charcoal can scarcely be regarded as a proper decoloriser in the preparation of the alkaloids, as it appears that many of these substances become removed from solution when digested with it. Morphia and strychnia are so affected, according to the experiments of Dr. Rand, of Philadelphia.[1]—ED.]

The following table, drawn up by Bussy,[2] shows the decolorising power of charcoal for indigo and molasses. The indigo test liquor contained $\frac{1}{1000}$th of this substance; and, therefore, every gramme of the solution decolorised represents a millegramme (=0·0154 troy gr.) of indigo absorbed by the charcoal. The molasses solution consisted of one part molasses and twenty parts of water.

---

[1] *Pharmaceutical Journal*, vol. ix. p. 78.

[2] *Journal de Pharmacie*, t. viii. p. 257, 1822.

Kind of Charcoal employed. (Weight always 1 gramme = 15·434 troy grains.)	*Solution of Indigo decolorised*	*Solution of Molasses decolorised*	*Decolorising power on Indigo.*	*Decolorising power on Molasses.*
	grammes.	grammes.		
1. Bone charcoal	32	9	1·00	1·00
2. Vegetable or animal oil charred with phosphate of lime	64	17	2·00	1·90
3. Bone charcoal washed with hydrochloric acid	60	15	1·87	1·60
4. No. 3 calcined with potash	1450	180	45·00	20·00
5. Calcined lamp-black	128	30	4·00	3·30
6. No. 5 calcined with potash	550	90	15·20	10·60
7. Charcoal of carbonate of soda decomposed by phosphorus	380	80	12·00	8·80
8. Charcoal of acetate of potash	180	40	5·60	4·40
9. Starch charred with carbonate of potash	340	80	10·60	8·80
10. Albumen charred with potash	1080	140	34·00	15·50
11. Gelatine charred with potash	1150	140	36·00	15·50
12. Blood charred with phosphate of lime	380	90	12·00	10·00
13. Blood charred with chalk	570	100	18·00	11·00
14. Blood charred with potash	1000	180	50·00	20·00

The effect of animal charcoal in removing substances from their solutions is not limited to colouring matters: it also deprives liquids of their bitter principles, alkaloids, resins, tannin, and even some metallic salts.[1] It is obvious, therefore, that it cannot be employed to decolorise poisonous liquids, since it deprives the solution of more or less of its deleterious ingredient, as well as of its colouring matter. Moreover, it is clear that manufacturers who employ animal charcoal to decolorise their solutions must lose part of their product; and hence in the preparation of disulphate of quina, &c. a loss must be sustained by the employment of charcoal as a decoloriser.

Dr. Garrod[2] has recently proposed purified animal charcoal as a general antidote in cases of poisoning; but I agree with Dr. Taylor[3] in regarding the experiments adduced in favour of it as inconclusive. Like many other agents it is certainly capable of acting mechanically, and of thereby impeding the action of poisons (see *ante*, pp. 158, 159, and 165), but beyond this there is no evidence of its antidotal power.

CARBO ANIMALIS PURIFICATUS, E. D.; *Purified Animal Charcoal.*—The *Edinburgh College* directs a mixture of lb. j. of Animal Charcoal and f℥xij. each of Water and of Hydrochloric Acid to be boiled, after digestion for two days; then dilute with two pints of water: the undissolved charcoal, collected in a filter of linen and calico, is to be washed with water till what passes through scarcely precipitates with solution of carbonate of soda. The charcoal is to be heated first moderately, and then to redness in a closely covered crucible.—In this process the hydrochloric acid dissolves the phosphate of lime, and decomposes the carbonate of lime and sulphuret of calcium, evolving carbonic and hydrosulphuric acid gases, and forming chloride of calcium, which remains in solution. The carbonate of soda, used by the Edinburgh College, is for the purpose of detecting the presence of a calcareous salt in the washings.

---

[1] Warington, *Memoirs of the Chemical Society*, vol. ii. p. 326, 1845; also Weppen, *Pharmaceutical Journal*, vol. v. p. 326, 1846.

[2] *Pharmaceutical Journal*, vol. v. p. 325, 1846.

[3] *On Poisons*, p. 84, 1848.

The formula of the *Dublin College* is as follows :—

> "Take of Ivory Black, lb. v. ; Muriatic Acid of commerce, Oiij. ; Water, Cong. iij. Oiij. ; Distilled Water, as much as is necessary. To the acid, diluted with Oiij. of water, gradually add the ivory black, and digest, with repeated stirring, at a gentle heat, for twenty-four hours. Pour on now a gallon of water, and when, after the mixture has been well agitated, the insoluble matters have subsided, remove the clear solution by decantation, or the syphon. Let this be done a second and a third time. Place now the black sediment on a calico filter, and wash it with distilled water until the washings cease to give a precipitate with nitrate of silver. Finally, let the product be dried in a stove or oven, a gentle heat being at first applied, which must be finally raised to between 300° and 400°."

Purified animal charcoal causes no effervescence when mixed with hydrochloric acid, by which the absence of carbonate of lime is shown. Nor is any precipitate produced by the addition of ammonia, or its sesquicarbonate, to the acid which has been digested in the charcoal, by which the absence of any dissolved calcareous matter is shown : caustic ammonia would precipitate any phosphate of lime in solution, while its sesquicarbonate would yield a white precipitate with chloride of calcium. Purified animal charcoal, "when incinerated with its own volume of red oxide of mercury, is dissipated, leaving only a scanty ash [about $\frac{1}{200}$th]."—*Ph. Ed.*

Purified animal charcoal is used as a decolorising agent in the preparation of the vegetable alkaloids, and as an antidote to poisons.

[Experiments by MM. Wassen and Graham, and also Drs. Garrod and Rand, seem to prove that the alkaloids, and some mineral poisons also, are prone to combine with purified animal charcoal, and become inert if sufficient of this latter substance be administered.

Dr. Garrod considers that animal charcoal has greater power of removing arsenic from its solutions than has the hydrated sesquioxide of iron ; but this is opposed to the results of the other above-mentioned experimenters.[1]—Ed.]

6. ACIDUM CARBONICUM.—CARBONIC ACID.

Formula CO^2. *Equivalent Weight* 22. *Equivalent Volume* 1 or □

History.—Although the ancients were acquainted with the poisonous properties of carbonic acid gas, Dr. Black, in 1757, was the first who explained its nature. The *spiritus lethalis* of the ancients is evidently this acid, as is also the *spiritus sylvestris* or *gas* of Paracelsus and Van Helmont. *Fixed air*, *acid vapour*, and *aërial acid*, are other synonymes for it.

Natural History.—It is a constituent of both kingdoms of nature.

a. In the Inorganised Kingdom.—Carbonic acid is a constituent of the atmosphere. In some parts of the world it is evolved from the earth in large quantities, particularly in old volcanic countries. Thus, in the vicinity of the Lake of Laach, Bischoff estimates the exhalation as equal to 600,000 lbs. daily, or 219,000,000 lbs. (equal to about

---

[1] *Pharmaceutical Journal*, vol. ix. p. 78.

1,855,000,000 cubic feet) annually![1] Some of the acid evolved in the Brohlthal, on the Rhine, is employed by him in the manufacture of chemical preparations on the large scale. D'Arcet has applied the carbonic acid gas evolved from the mineral waters of Vichy to the preparation of alkaline bicarbonates.[2] Most persons are familiar, by report, with the *Grotto del Cane*, near Naples. It is a cavity in a rock, through the fissures of which carbonic acid is evolved. It has received its name from the practice of putting dogs into it, who fall down suffocated. Dr. Alfred Taylor[3] analysed the air contained in this grotto, and found that it consisted of 94 per cent. of carbonic acid. [The gas is constantly evolved from fissures in the soil of the grotto. The current is sensibly warmer than that of the surrounding air; and the gas as it escapes is loaded with humidity. We found that ignited phosphorus was immediately extinguished by the gas when lowered to the stratum, which rises above the soil to about fifteen inches.—ED.] The *Valley of Poison*, in Java, which has been described by Loudon, is another spot where this acid escapes from the earth. It is a cavity of an oval form, about three quarters of a mile in circumference, and from thirty to thirty-five feet deep; filled to the height of about eighteen feet with carbonic acid gas. The bottom of it is covered with the skeletons of men and various other animals who have fallen victims to its destructive operation. If a traveller should be so unfortunate as to enter it, he cannot be sensible of his danger until too late to return. Mr. Loudon thrust a dog in: the animal fell in fourteen seconds. A fowl thrown in appeared to be dead before it reached the ground!!

Carbonic acid gas is frequently met with in mines and wells, and is termed by miners *choke damp* (from the German *Dampf*, vapour).

Few mineral waters are without this acid; and in some it exists in such quantity as to give them a sparkling or effervescent quality (see p. 309).

Lastly, carbonic acid is found (native) in combination with various bases: as with soda, baryta, strontian, lime, magnesia, and the oxides of manganese, zinc, lead, iron, and copper. According to Sir H. De la Beche, the average amount of carbonic acid locked up in every cubic yard of limestone is about 16,000 cubic feet.

It is produced in the burning of limestone (carbonate of lime) at limekilns, and by the combustion of charcoal, coal, wood, coal-gas, the fire-damp of coal-mines, and other combustibles containing carbon.

β. IN THE ORGANISED KINGDOM.—Carbonic acid gas is exhaled by plants in dark or shady places, and hence is met with in greenhouses, especially during the night. Animals develope it in the process of respiration; and, therefore, in crowded rooms, with imperfect ventilation, accidents have sometimes happened from the accumulated carbonic acid. It is produced by the decomposition of organic matters, as during the fermentation of saccharine fluids (hence the danger of descending into brewers' vats), and in the destructive distillation of animal substances. Free or combined carbonic acid is found in the blood, urine, bones, &c.

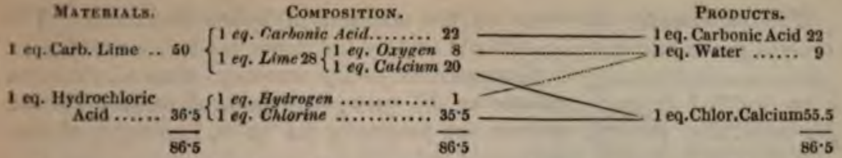
PREPARATION.—Carbonic acid gas may be procured in various ways, but for ordinary purposes is usually obtained by the action of a mineral acid on carbonate of lime. Soda-water makers and the preparers of the alkaline bicarbonates obtain it by the action of sulphuric acid on common whiting. In the laboratory, hydrochloric acid and white marble are generally employed. It is most readily prepared in a tubulated glass retort, and may be collected over water. The ordinary hydrochloric acid of the shops should be diluted with four or five times its volume of water. In order to deprive it of any hydrochloric vapour, it should be washed by passing it through water. By the reaction of one equivalent of hydrochloric acid on one equivalent of carbonate of lime, we obtain one equivalent of chloride of calcium, one equivalent of water, and one equivalent of carbonic acid.

---

[1] De la Beche, *Theoretical Geology*.

[2] See the description and drawing of the apparatus used, in the *Dictionnaire de l'Industrie, Manufacturier, Commerciale et Agricole*, t. iii. p. 60, art. *Carbonates*, Paris, 1835.

[3] *Med. and Phys. Journal*, Oct. 1832.



MATERIALS.		COMPOSITION.		PRODUCTS.	
1 eq. Carb. Lime ..	50	1 eq. Carbonic Acid........	22	1 eq. Carbonic Acid	22
		1 eq. Lime 28 { 1 eq. Oxygen	8	1 eq. Water	9
		1 eq. Calcium	20		
1 eq. Hydrochloric Acid	36·5	1 eq. Hydrogen	1		
		1 eq. Chlorine	35·5	1 eq. Chlor. Calcium	55.5
	86·5		86·5		86·5

By pressure, carbonic acid gas may be condensed into a liquid, called *liquid carbonic acid.* This by an intense degree of cold may be frozen, and converted into *solid carbonic acid.* The necessary degree of cold is obtained by allowing the liquid acid to escape into the air; and by the evaporation of one part, a sufficient cold is produced to freeze another part.[1]

PROPERTIES. α. *Of the gaseous acid.*—At ordinary temperatures and pressures, carbonic acid is gaseous. In this form it is invisible, irrespirable, has a faint odour, and a sharp taste. Its specific gravity is 1·5245. It is neither combustible nor a supporter of combustion, except in the case of potassium, which, when heated in this gas, takes fire, the products of the combustion being carbon and carbonate of potash. It extinguishes most burning bodies when introduced into it in the ignited condition. It reddens litmus feebly.

β. *Of the liquid acid.*—Under a pressure of 36 [38½, Faraday,[2]] atmospheres at 32°, carbonic acid is a limpid, colourless liquid, which is insoluble in water and in the fat oils, but is soluble in all proportions in alcohol, ether, oil of turpentine, and carburet of sulphur. Its refractive power is less than that of water. Its expansibility by heat is greater than that of gases; for when heated from 32° to 86° F., its bulk increases from 20 to 29 volumes, while the pressure of its vapour augments from 36 to 73 atmospheres.[3]

γ. *Of the solid acid.*—When the pressure is removed from liquid carbonic acid, by opening a stopcock in the condensing vessel, the cold produced by the evaporation of one part is so great that another part freezes.

As thus obtained, solid carbonic acid is a white snow-like body. It melts at −70° F. or −72° F., and when resolidified by a bath of low temperature, it then appears as a clear, transparent, crystalline, colourless body, like ice (Faraday). In the white snow form, solid carbonic acid may be handled with impunity, on account of its being a bad conductor of heat, although its temperature is −148° F., or less. But if it be mixed with ether to give it contact, a most intense degree of cold is produced by it. This may be increased by placing the mixture under the exhausted receiver of the air pump. In this way Faraday obtained a temperature of −166° F.

Characteristics.—Carbonic acid gas is recognised by its feebly reddening litmus, by being incombustible and a non-supporter of combustion (except in the case above mentioned), and by its forming, with a solution of lime or of baryta, a white precipitate, soluble in acetic acid or in excess of carbonic acid. Carbonic acid is readily absorbed by a solution of caustic potash.

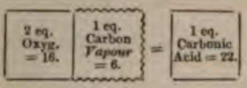
---

[1] For details respecting the liquefaction and solidification of carbonic acid, see Thilorier, *Ann. Chim. et Phys.* lx. 427, 1835; Adams, in Brande's *Manual of Chemistry;* and Graham's *Elements of Chemistry*, 2d edit. p. 69.

[2] *Philosophical Transactions* for 1845, p. 166.

[3] At the Ecole de Pharmacie, in Paris, the apparatus employed in the condensation of the gas burst, and destroyed the *préparateur* (see *Journal de Pharmacie*, t. xxvii.; and *London Medical Gazette*, April 16, 1841).

The *carbonates* effervesce on the addition of hydrochloric acid. The evolved gas is known to be carbonic acid by the characters before stated.



COMPOSITION. — By burning charcoal in one volume or 16 parts, by weight, of oxygen gas, we procure one volume or 22 parts, by weight, of carbonic acid gas.

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Dumas et Stas.*	*Saussure.*
Carbon	1	6	27·27	27·27	27·38
Oxygen	2	16	72·73	72·73	72·62
Carb. Acid	1	22	100·00	100·00	100·00

	Vol.	*Sp. gr.*
Carb. vapour[1]	1	0·4189
Oxygen gas	1	1·1056
Carb. Acid Gas	1	1·5245

	Vol.	*Sp. gr.*
Carb. Oxide gas	1·	0·9717
Oxygen gas	0·5	0·5528
Carb. Acid Gas	1·	1·5245

PHYSIOLOGICAL EFFECTS. α. *On Vegetables.*—Carbonic acid gas is injurious to seeds, and diminishes or stops their germination. An aqueous solution of carbonic acid applied to the roots of plants promotes vegetation. An atmosphere containing not more than 1·8th of its volume of carbonic acid promotes the vegetation of plants exposed to the solar rays, but is injurious to those which grow in the shade.[2] The carbon of plants is derived from carbonic acid, which they take in from the atmosphere, decompose, retain the carbon, and evolve (partially or wholly, according to circumstances) the oxygen. Humus nourishes plants by presenting a slow and lasting source of carbonic acid, which is absorbed by the roots.[3]

β. *On Animals.*—The *respiration* of carbonic acid is deleterious and fatal to all classes of animals. It operates as a narcotic or stupefacient poison. That it is a positive poison, and does not act merely by excluding oxygen, as some have supposed, seems to be proved by three facts:—firstly, an atmosphere composed of 79 parts of carbonic acid and 21 of oxygen acts as a poison, although there is as much oxygen present as there is in atmospheric air; secondly, one bronchial tube of the land-tortoise may be tied, without any serious injury to the animal; but if, instead of tying it, the animal be made to inhale carbonic acid gas by it, death takes place in a few hours;[4] and, thirdly, "the cases of insidious poisoning by small doses of carbonic acid scarcely admit of explanation, save on the grounds of the essentially and specifically poisonous action of carbonic acid gas, when sufficiently diluted to become respirable."[5] The impression produced on the pulmonary extremities of the par vagum, by the carbonic acid in the lungs, is supposed by some physiologists to be the ordinary stimulus to inspiration.[6] According to the experiments of Nysten,[7] this gas may be *injected into the venous system* in large quantity, without stopping the circulation, and without acting primitively on the brain; but when more is injected than the blood can dissolve, it produces death by distending the heart, as when air is injected into the veins. *Applied to the skin of animals,* free access of common air to the lungs being preserved, it produces, if the experiment be continued long enough, death.

---

[1] The specific gravity of carbon vapour is assumed to be 1·5245 − 1·1056 = 0·4189.

[2] Saussure, *Recherches*, p. 25 et seq., Paris, 1804.

[3] Liebig's *Organic Chemistry in its application to Agriculture and Physiology*, edited by Lyon Playfair, Ph.D., London, 1840.

[4] Christison, *Treatise on Poisons*, 3d edit. p. 745.

[5] Dr. Golding Bird's experiments, in the *Guy's Hospital Reports*, vol. iv. p. 75; also *London Medical Gazette*, new series, vols. i. and ii. for 1838–9.

[6] Dr. M. Hall *On the Diseases and Derangements of the Nervous System*, p. 66, London, 1841.

[7] *Recherches*, p. 88.

γ. *On Man.*—If an attempt be made to *inhale* pure carbonic acid gas, the glottis closes spasmodically, so as to prevent the smallest portions from entering the lungs.[1] When mixed with more than twice its volume of air, this gas ceases to provoke spasm of the glottis, and may be taken into the lungs. It then acts as a narcotic poison. Its specific influence is exercised on the central organs of the cerebro-spinal system, which it probably gains access to through the medium of the blood. Its action on the nervous system does not depend on its impeding the arterialization of the blood; because death may occur from the respiration of an atmosphere containing sufficient oxygen to support life *per se*, but with which is mixed carbonic acid gas. It is impossible to state the maximum quantity of this gas which may be present in the air without exciting its effects: it probably varies for different individuals, some persons being much more susceptible of its action than others. If the proportion of carbonic acid be large, the effects are almost immediately developed; whereas, if the proportion be small, they are very slowly manifested. Dr. G. Bird has shown that an atmosphere containing five per cent. of carbonic acid proved fatal to a bird in thirty minutes; and it is probable that the continued respiration of an atmosphere containing a very considerably smaller proportion of carbonic acid, would be attended with dangerous and even fatal consequences.

The earliest symptom usually experienced by persons exposed to an atmosphere containing carbonic acid gas is throbbing headache, with a feeling of fulness and of tightness across the temples and in the occipital region. Giddiness, loss of muscular power, a sensation of tightness at the chest, augmented action of the heart, and often palpitation, succeed. The ideas become confused, and the memory partially fails. A buzzing noise in the ears is next experienced; vision is impaired; and a strong tendency to sleep succeeds, or actual syncope ensues. The pulse falls below its natural standard, the respiration becomes slow and laborious, the surface cold and often livid, but the eyes retain their lustre. Convulsions, sometimes accompanied with delirium, foaming at the mouth, and vomiting, come on, and are terminated by death. On post-mortem examination, engorgement of the cerebral vessels, and sometimes serous or even sanguineous effusion, are the usual appearances.[2]

Applied to the skin (care being taken that it be not inhaled), it produces a sensation of warmth and prickling or tingling, sometimes accompanied by pain, increased frequency of the pulse, sweating, and excitement of the nervous system. M. Collard de Martigny (quoted by Dr. Christison) experienced weight in the head, obscurity of sight, pain in the temples, ringing in the ears, giddiness, and an undefinable feeling of terror. *Taken into the stomach*, dissolved in water, or in the form of effervescing draughts, it allays thirst, and diminishes preternatural heat, thus acting like the other dilute acids. If it be evolved in the stomach, it distends this viscus, excites eructations, and checks both nausea and vomiting. It appears to promote the secretions of the alimentary tube, to assist the digestive process, to allay irritation, and to act as a refreshing and exhilarating substance. It is said to be diuretic and diaphoretic. But Wöhler and Stehberger expressly state that the use of carbonic acid did not increase the quantity of this substance in the urine.[1] When drunk too quickly, and in large quantity, water impregnated with this gas has been known to excite giddiness and intoxication;[2] and it is probable that champagne is indebted to this substance for part of its intoxicating powers. *Applied to ulcers and suppurating surfaces*, carbonic acid gas acts as a stimulant, improves the quality of the discharge in ill-conditioned and indolent ulcers, retards the putrefaction of the secreted matters, diminishes the unpleasant odour of foul and gangrenous sores, and promotes the separation of the dead and mortified parts.

---

[1] Davy, *Researches*, p. 472.

[2] For further details I must refer the reader to Dr. Bird's paper before cited.

Uses. α. *When inhaled.*—In some diseases of the lungs, particularly phthisis, it has been proposed to mix carbonic acid gas with the atmospheric air breathed by the patient, with the view of lessening the stimulant influence of the oxygen, to diminish the quantity and improve the quality of the matter expectorated, and at the same time to relieve the hectic symptoms. But the practice is dangerous. Part of the benefit said to have been derived by consumptive patients from a residence in cow-houses, has been ascribed to the inhalation of carbonic acid gas (see p. 20).

β. *Taken into the stomach,* carbonic acid is a most valuable remedy for checking vomiting, and diminishing irritable conditions of this viscus. The best mode of exhibiting it is, I believe, in the form of an effervescing draught, composed of citric acid and bicarbonate of potash. In fever, it is an excellent refrigerant; being especially serviceable in those cases which are accompanied with gastric irritation. In that form of lithiasis attended with a white or phosphatic deposit in the urine, carbonic acid water may be taken with advantage; but in this case the common effervescing draught (made of a vegetable acid and a carbonated alkali) must not be substituted for it, on account of the alkaline property communicated by the latter to the urine (see *ante*, p. 184). [It is by no means correct to ascribe a mischievous action to remedies which render the urine alkaline in all cases of phosphatic diathesis. The greatest benefit is occasionally derived from them where the phosphatic deposit occurs in consequence of disease of the lining mucous urinary surfaces, which secrete alkaline fluid and so render the urine alkaline.[3]—Ed.] From its antiseptic qualities, carbonic acid has been administered internally, in those diseases which are supposed to be connected with a putrescent tendency, as Cholera Asiatica, typhoid fevers, &c.[4]

γ. *Clysters of carbonic acid gas* have been employed in certain affections of the rectum and colon,—for example, ulceration of the rectum, especially when of the kind commonly denominated cancerous. Mr. Parkin[5] has recommended them in dysentery. The gas may be introduced into the rectum from a bladder, or solutions of tartaric acid and bicarbonate of soda may be injected in the usual way.

---

[1] Tiedemann's *Zeitschrift für Physiologie*, Bd. i. und ii.

[2] Fodéré, *Medecine Légale*.

[3] See Rees on the *Analysis and Treatment of Urinary Diseases*, 2d edit. p. 135-6.

[4] See Dobson's *Medical Commentary on Fixed Air*, 2d edit. London, 1785.

[5] *On the Efficacy of Carbonic Acid Gas in the Diseases of Tropical Climates; with Directions for the Treatment of Acute and Chronic Stages of Dysentery.* Reviewed in the *London Medical Gazette*, vol. xviii. p. 777, 1836.

δ. *A stream of carbonic acid gas* has been applied to the *uterus* with great benefit, in a painful condition of this viscus, as I have already mentioned (see p. 135).

ε. *Applied to the skin*, care being taken that the gas be not inhaled, it is employed either in its gaseous form, or dissolved in water. It is, of course, adapted to those cases where it is desirable to excite the vascular system, especially of the skin, and to cause perspiration; while, on the other hand, it is objectionable in inflammatory cases. In chlorosis, amenorrhœa, dyspepsia, hysteria, scrofula, &c., it has also been found useful.

ζ. It has been *applied to cancerous and other ulcers*, to allay pain, to improve the quality of the secretions, and to check sloughing. It is readily administered by means of a tube connected with a bottle generating the gas. In this case it should be procured by the action of dilute sulphuric acid on marble; for, if hydrochloric acid be employed, the gas requires washing, to remove any of this acid which may pass over with it. Or it may be used in the form of solution, in which case carbonic acid water is employed. Or, lastly, we may apply the *yeast poultice* (see *Cataplasma Fermenti*).

η. *In ophthalmia* of a chronic kind, a stream of carbonic acid gas, directed on the inflamed part, has appeared to be serviceable. I have seen it used in a case of scrofulous ophthalmia: the patient recovered under its use, after the ordinary plans of treatment had been unsuccessfully tried.

ADMINISTRATION.—Internally, carbonic acid may be administered under the form of *carbonic acid water* or the *effervescing draught*. The latter, however, cannot always be employed as a substitute for the former. Where no objection exists to the use of the vegetable salts of potash, the ordinary *effervescing draught* may be administered. In febrile disorders, when the stomach is in a very irritable condition, I prefer a draught made with citric acid and the bicarbonate of potash, to other modes of employing carbonic acid.

Another mode of administering carbonic acid is under the form of the *acidulous* or *carbonated mineral waters* (see *ante*, p. 309).

ANTIDOTES.—In accidents arising from the inhalation of carbonic acid gas, proceed as follows:—Remove the patient immediately into the open air, and place him on his back, with his head somewhat elevated. Produce artificial respiration by pressing down the ribs, forcing up the diaphragm, and then suddenly removing the pressure. Dash cold water over the body, and abstract a small quantity of blood either by venesection or cupping. Apply bottles of hot water to the feet. Stimulants of various kinds may be employed, either internally by the stomach, or in the form of frictions, or inhalations of ammonia, or air impregnated with chlorine gas.

AQUA ACIDI CARBONICI; *Carbonic Acid Water; Bottle Soda Water; Soda Water from the Fountain; Artificial Seltzer Water.*—This is prepared by condensing carbonic acid gas (generated by the action of sulphuric acid on whiting) in water. The operation is effected by means of *Tyler's Improved Soda Water Apparatus* (figs. 49 and 50).[1]

---

[1] These figures are taken from Ure's *Dictionary of Arts and Manufactures*, p. 1156, London, 1839. See also *Pharmaceutical Journal*, vol. v. p. 365.

A. Lead generator for making the gas. *B.* Lead pot for holding sulphuric acid. *C.* Handle for moving the agitator of the receiver, which stirs up the ingredients in the lead generator. *a.* Cap and screw for charging the lead pot with sulphuric acid. *b.* Swivel-joint, which is movable, for occasionally throwing in portions of sulphuric acid for generating gas. *c.* Stuffing-box for agitator. *d.* Large cap and screw for charging the lead generator with whiting and water. *e.* Cap and screw for emptying contents of ditto. *D.* Lead pipe to convey the gas from the lead generator to gasometer. *E.* Wood tub, filled with water, for gasometer to work in. *F.* Copper gasometer. *G.* Strong iron frame for gasometer and tub to stand on, firmly fixed together by three wrought-iron rods, *f f*, *g g*. Two pulleys for carrying rope and counterbalance weight, *h*, for balancing copper gasometer. *i.* Cock for discharging atmospheric air contained in the gasometer before making the gas. *k.* Cock for occasionally emptying the water out of the tub. *l.* Union-joint, to which is fixed a copper pipe, passing through the water in the tub, to deliver the gas as generated into the copper gasometer. *m.* Another union-joint, with a similar copper pipe passing through the water in the tub, and projecting two or three inches above the surface of the water, to convey the gas from the copper gasometer to the soda water machine. *H H.* Condenser for aërating the soda water. *I.* Safety valve. *K K.* Bottling valve. *L.* Bottling nipple. *M M.* Soda water pump. *N.* Valve-piece. *O O.* Piston of the pump. *P.* Pipe for conducting gas from the gasometer to pump. *Q.* Copper pan for holding the water or solution of soda. *R.* Copper pipe for conducting the solution of soda to the force pump. *S S.* Two cocks for regulating the admission of the solution and gas to the pump. *T.* Copper pipe through which the soda water is forced to the condenser. *U.* Pinion wheel, to give motion to the agitator revolving inside the condenser. *V V.* Wheel for driving ditto. *W W.* Cast-iron frame carrying machinery. *X X.* Cast-iron fly-wheel. *Y.* Wrought-iron crank. *Z Z Z.* Wood stools and curb, upon which the whole of the machinery is fixed.

FIG. 49. FIG. 50.

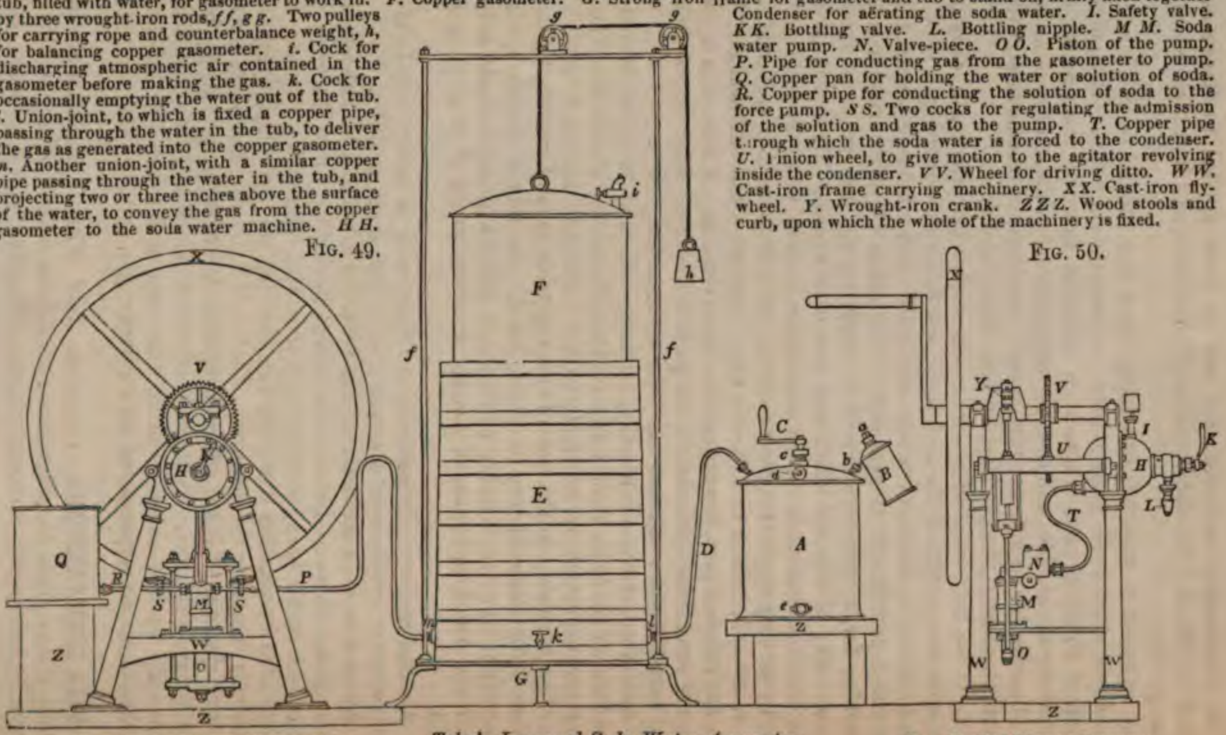


FIG. 49. Front View of the Machine. *Tyler's Improved Soda Water Apparatus.* FIG. 50. End View of the same.

At the ordinary temperature and pressure of the atmosphere, one volume of water absorbs one volume of carbonic acid gas, and acquires a sp. gr. of 1·0018. By doubling the pressure, the quantity of gas absorbed by the water is doubled, and so on for other degrees of pressure; for Dr. Henry has shown that the quantity of gas forced into the water is directly as the pressure. In the United States' Pharmacopœia five volumes of gas are directed to be condensed in one volume of water. Mr. Webb tells me that a pressure of eleven atmospheres is used in the preparation of his soda water.

The *Bottle Soda Water* of the shops is, in general, carbonic acid water only. Mr. Webb, and some few other manufacturers, introduce a small portion of soda (see *Aqua Sodæ Supercarbonatis*).

Carbonic acid water is a brisk, sparkling liquid. It has a pungent acidulous taste; reddens litmus; and causes, with lime water, a white precipitate (*carbonate of lime*), which is re-dissolved by an excess of carbonic acid water.

Some of the bottle soda water sold in the shops is contaminated with lead, which it derives either from being prepared in leaden vessels, or from its passage through leaden pipes. The presence of lead may be detected by the addition of sulphuretted hydrogen or hydrosulphuret of ammonia, which occasions a dark colour or black precipitate (*sulphuret of lead*).

Carbonic acid water is a refreshing, refrigerant beverage, operating as an anti-emetic, diaphoretic, and diuretic. In febrile disorders, it is used to allay thirst, check nausea, and promote secretion. In lithiasis it is employed to check the formation of the phosphates in the urine. It is a convenient vehicle for the exhibition of many medicines, the nauseating qualities of which it diminishes. By the aid of it, extemporaneous imitations of carbonated magnesian and carbonated chalybeate water may be readily made (see *Aqua Magnesiæ Supercarbonatis* and *Aqua Ferri Supercarbonatis*).

For domestic use, especially in the sick chamber, Mayo's *patent syphon vase*[1] is a convenient receptacle for carbonic acid water. From this vessel the effervescing liquid may be drawn off at pleasure, in any required quantity, without explosion, loss, or injury to the residue in the vase.

ORDER IV. BORON AND ITS COMPOUND WITH OXYGEN.

BORON, *Boracium*, or *Borium*. Symbol B. Equivalent weight 11. It is odourless and tasteless; but beyond this its effects on the system are unknown. It has never been employed in medicine.

7. ACIDUM BORACICUM.—BORACIC ACID.

HISTORY.—Beecher[2] "was undoubtedly the first discoverer of boracic acid, though the credit of the discovery has usually been given to Homberg," who, in 1702,[3] obtained it in small shining plates, which have been called *sedative* or *narcotic salt* (*sal sedativum Hombergi*). In the year 1776 it was discovered in the lagoons (*lagoni*) of Tuscany by Hoefer[1] and Mascagni,[2] and more recently by Mr. Smithson Tennant,[3] Dr. Holland,[4] and Mr. Lucas,[5] in the crater of Vulcano, one of the Lipari Islands.

---

[1] *Pharmaceutical Journal*, vol. v. p. 255.

[2] Thomson's *History of Chemistry*, vol. i. p. 248, London, 1830.

[3] *Histoire de l'Académie Royale des Sciences*, 1702; *Mémoires*, p. 50.

Natural History.—Boracic acid is peculiar to the inorganised kingdom. It is found both free and combined.

α. *Free Boracic Acid.*—The boracic acid *lagoons* of Tuscany are spread over a surface of about thirty miles. There are nine establishments for the manufacture of this acid; viz. at Monte Cerboli, Monte Rotondo, Sasso, Serazzano, Castelnuovo, San Frederigo, Lustignano, Lurderello, and Lago. They are the property of one individual (M. Larderel, now Count of Monte Cerboli), to whom they are the source of great wealth. The earth (principally calcareous) of this part continually evolves aqueous and sulphuric vapours, which, when they burst with a fierce explosion, produce boracic acid.[6] The phenomena are explicable on the supposition that water gains access to immense masses of sulphuret of boron contained in the interior of the earth. By the mutual reaction of these substances, great heat, boracic acid, and sulphuretted hydrogen, would be evolved. The latter taking fire would produce water, sulphur, and sulphurous acid.[7] In consequence of being found at Sasso, native boracic acid has obtained the name of *sassoline*.

β. *Combined with bases.*—Boracic acid is found native combined with soda (forming *tincal*), and with magnesia (constituting *boracite*). It is also found in the minerals called *datholite*, *botryolite*, *schorl*, *apyrite*, and *axynite*.

Process of Manufacture.—Boracic acid is obtained in Tuscany in the following manner:—"Round the more considerable fissures a circular basin is dug, about four feet deep, and usually three or four yards across. These basins, which are called *lagoni*, being situated at different levels, the water of a rivulet is admitted into them, which, mixing with the black mud at the bottom, is made to boil up violently by the issues of vapour within its circuit. The water is generally confined in each basin for twelve [twenty-four, *Payen*] hours at a time, during which period it becomes saturated to a certain extent with acid from the steam which has passed through it. It is then drawn off from the higher basin to one beneath it, where it remains an equal length of time, till at length it reaches a building at the bottom of the hill, in which the process of evaporation is conducted." Here it enters a reservoir or cistern, where it is allowed to repose till it has deposited the mud which it held in suspension. Having cleared itself of impurities, the water is then drawn off from the cistern into flat leaden pans, under which some of the natural steam is conducted by brick drains about two feet under ground, and by this heat is evaporated. This process requires about sixty hours, the water passing successively from the pans at the upper extremity into others at the centre, and from thence into others at the lower extremity of the building, by means of leaden syphons.

---

[1] *Memoria sopra il Sale sedativo di Toscana ed il Borace*, &c., Firenze, 1788 (übers. von B. F. Hermann, Wien.

[2] *Memorie della Societa Italiana*, viii. 487.

[3] *Transactions of the Geological Society*, vol. i. p. 388, 1811.

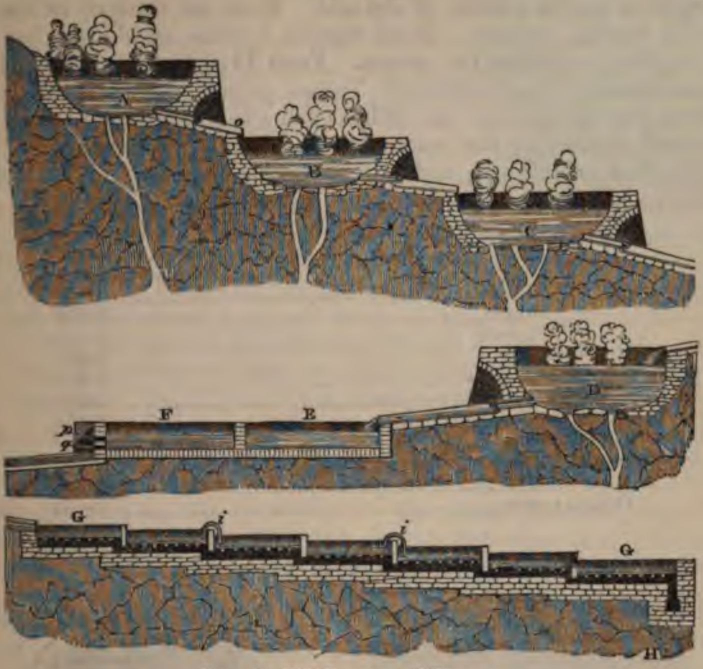
[4] *Travels in the Ionian Islands, Albania, Thessaly, Macedonia, &c. during the Years* 1812–13, p. 9, London, 1815.

[5] *Annales de Chimie et de Physique*, t. ii. p. 443, 1819.

[6] For further details consult Tancred *On the Collection of Boracic Acid from the Lagoni of Tuscany*, in the *Transactions of the Ashmolean Society*, vol. i. Oxford, 1837; Dr. Bowring *On the Boracic Acid Lagoons of Tuscany*, in the *London and Edinburgh Philosophical Magazine*, vol. xv. p. 21, London, 1839; and Payen, *Ann. Chim. et Phys.* 1841.

[7] Dumas, *Traité de Chimie*, t. i. p. 380, Paris, 1828.

FIG. 51.



Boracic Acid Lagoons of Tuscany.

A, B, C, D. Lagoons.—The vapours enter at the bottom, and escape through the water into the air. When the water in the upper lagoon, A, is sufficiently charged with acid, it is allowed to run through the tube *o* into the lower lagoon, B. In this way it passes successively from B to C, from C to D, and from D into the reservoir E.

E, F. Reservoirs or Cisterns.—In these the solution is allowed to rest and deposit mechanical impurities. By the removal of the upper plug, *p*, the solution escapes into the upper evaporating pan, G.

G G. Leaden Evaporating Pans.—They are supported by rafters, and are heated by the aqueous vapours which enter at H, and are confined in drains. The acid solution is conveyed from one pan to another by means of leaden siphons, *i i*.

Having arrived at a proper state of concentration, it is then conducted into wooden tubs, in which it cools for about five days, during which the crystallisation of boracic acid takes place on the sides of the tubs, and on the stick in the centre. The acid having been removed from the tubs is placed in a basket to drain, and is then spread on the floor of a closed chamber, heated by vapour, to dry. The acid, thus prepared, is sent in casks to Leghorn.[1]

[This process has of late years been somewhat simplified. Thus, the water from the last lagoon is now allowed to flow on to rectangular tables of lead of twenty or thirty metres, divided by transverse parallel divisions, but whose height is never raised above that of the edges. These tables have an inclination of two or three degrees. The hot vapours for evaporating are conducted in such a manner that they act upon the lower surface of the tables. The water passes from one compartment to another, and when it arrives on the last begins to deposit crystals of the acid. These are removed by the workmen with wooden scrapers. Great expense is thus saved, very few hands being required to conduct the process. From 1818 to 1845, the quantity of acid manufactured was 33,349,097 Tuscan pounds. From 1839 to 1845, the mean quantity has been two millions and a half of pounds [1]—Ed.]

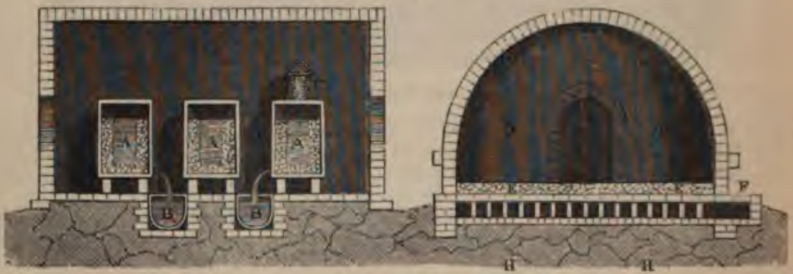
---

[1] Tancred, *op. supra cit.*; also Bowring, *op. supra cit.*; and Payen, *op. supra cit.*

The acid obtained by this process is called *Tuscany boracic acid.* It has a slight yellow or buff tint; and its composition, according to Wittstein,[2] is as follows:—

Boracic acid (crystallised)	76·494
Sulphate of ammonia	8·508
" magnesia	2·632
" lime	1·018
" soda	0·917
" potash	0·369
" iron	0·365
" alumina	0·320
" protoxide manganese	traces
Chloride of ammonium	0·298
Silicic acid	1·200
Sulphuric acid (combined with boracic acid)	1·322
Water	6·557
Organic matter	traces
	100·000

Fig. 52.



Crystallisation and Drying Chambers (old process).

A A A. Wooden tubs lined with lead, in which the acid crystallises.
B B. Mother liquor.
C. Basket in which the crystallised acid is placed to drain before it is conveyed to the drying chamber.
D D. Drying chamber.
E E. Boracic acid drying on the floor (F), between which and the lower floor (H) the hot vapour circulates.

Tuscany boracic acid is purified, after its arrival in this country, by solution and crystallisation.

Boracic acid may also be obtained by dissolving borax in hot water, and adding half its weight of oil of vitriol. As the solution cools, crystals of boracic acid (retaining a little sulphuric acid) are deposited, which must be well washed. Or borax may be decomposed by hydrochloric acid, by which a purer boracic acid is procured.[3]

---

[1] See *Bulletin de la Société Géologique de France; Pharmaceutical Journal*, vol. x. p. 93.

[2] Buchner's *Repertorium*, 2te Reihe, Bd. xxii. p. 145, 1840.

[3] *Pharmaceutical Journal*, vol. ii. p. 51.

PROPERTIES.—Crystallised boracic acid belongs to the doubly oblique prismatic system (see *ante*, p. 147). It occurs in the form of white, transparent, pearly hexagonal scales, which are odourless, have a weak, scarcely acid, taste, and communicate a wine-red tint to litmus. At 60° the crystallised acid requires 25·66 times its weight of water to dissolve it, but only 2·97 times at 212°. When its solution is boiled a portion of the acid is volatilised along with the water. It dissolves readily in spirit of wine. When sufficiently heated, it evolves its water of crystallisation, melts, forming a transparent liquid, which, by cooling, becomes a brittle gas (*vitrified boracic acid*).

Characteristics.—An alcoholic solution of boracic acid burns with a beautiful green flame. "If a salt is suspected to contain boracic acid, a little sulphuric acid may be added, and the mixture dried by a gentle heat: this will separate the boracic acid, and if any chlorine or hydrochloric acid be present (which also gives a greenish-blue flame) it will be dissipated. Alcohol is then poured upon the dry mass, and a bit of cotton moistened and inflamed: if the quantity of boracic acid be very minute, the green tint does not at first appear: but after a time, especially if the cotton be moved about with a glass rod, the point of the flame assumes a green hue: the absence of copper must always be ensured" (Brande). A hot aqueous solution of the acid renders turmeric paper brown, like the alkalies.[1] The colour of rhubarb paper is unchanged by it. Before the blowpipe, boracic acid fuses, and forms a glass which may be tinged blue by chloride of cobalt, and rose-red by terchloride of gold. A red hot platinum wire dipped into a pulverised mixture of equal parts of a boracic salt and bisulphate of potassa gives a green tint to the flame of the blowpipe. A mixture of one part of vitrified boracic acid, finely pulverised, two parts of fluor spar, and twelve parts of oil of vitriol, evolves, by heat, the fluoride of boron, recognised by its forming dense white fumes in the air, and by its charring paper, wood, &c.

COMPOSITION.—The following is the composition of boracic acid:—

	At.	*Eq.Wt.*	*Per Ct.*	*Berzelius.*
Boron	1	11	31·43	31·1896
Oxygen ...	3	24	68·57	68·8104
Dry Boracic Acid	1	35	100·00	100·0000

	At.	*Eq.Wt.*	*PerCt.*	*Davy.*	*Berzel.*
Dry Boracic Acid	1	35	56·45	57	56
Water	3	27	43.55	43	44
Crystallised Boracic Acid...	1	62	100·00	100	100

PHYSIOLOGICAL EFFECTS AND USES.—Homberg ascribed to this acid sedative, anodyne, and antispasmodic properties. It was said to be useful in ardent fever, delirium, nervous affections, convulsions, &c., and to be devoid of the inconveniences which attend the use of opium, though it was thought to be injurious in persons with delicate chests, and in inflammatory affections of the *primæ viæ*. Experience, however, has not confirmed these opinions; and it is now considered to be inert, or nearly so. Cullen[2] gave it in large doses without observing that it produced any effect on the human body. It is, therefore, not employed directly in medicine; but it is extensively used in the manufacture of borax (see *Sodæ Biboras*).

---

[1] Faraday, *Quarterly Journal of Science*, vol. ix. p. 403.

[2] *Materia Medica*, p. 341.

Order V. PHOSPHORUS AND PHOSPHORIC ACID.

8. PHOSPHORUS.—PHOSPHORUS.

Symbol P. *Equivalent Weight* 32. *Equivalent Volume of Phosphorus Vapour* 0·5 or □

History.—This substance was discovered, in 1669, by Brandt, an alchymist at Hamburgh; and received its name from being luminous in the dark (from φῶς, *light*, and φέρω, *I carry*).

Natural History.—Phosphorus is found in both kingdoms of nature.

α. In the Inorganised Kingdom.—It is comparatively rare in the mineral kingdom. Various phosphates are found native, but in small quantities: those of lime, lead, iron, copper, manganese, uranium, and yttria, may be mentioned as examples. Phosphate of lime is an important constituent of the organic exuviæ entombed in the fossiliferous rocks. It is a constituent of the deep-well water of the London basin (see p. 299). The luminous appearance called *jack with a lantern* has been ascribed to phosphuretted hydrogen.

β. In the Organised Kingdom.—Phosphoric acid, free or combined with lime, potash, or iron, is found in various vegetables.[1] Phosphorus is a constituent of animals: in some cases it is in combination with oxygen, and a base, as in the bones, urine, &c.; in other instances, as in the brain, it is uncertain in what form it exists.

Preparation.—Phosphorus is usually obtained from bone-ash. When bones are burned in the air to whiteness, the ash which remains consists principally of phosphate and carbonate of lime, mixed with minute portions of other matter (see *ante*, p. 324). The phosphate of lime of bones is according to Berzelius $8CaO,3PO^5$; but more recent investigations lead to the conclusion that it is a tribasic phosphate, $3CaO,PO^5$. The bones of the sheep are preferred for yielding phosphorus, as the ash which they yield is less compact, and more easily attacked by acid. Sulphuric acid is gradually added to the bone-ash previously made into a thin paste with water. Carbonic acid is evolved, while sulphate and a soluble superphosphate of lime are formed. Water is added, and at the end of twenty-four hours the liquor is filtered and evaporated in leaden or copper pans to the consistence of syrup or honey. It is then mixed with charcoal, dried, and distilled in an earthen retort. The charcoal abstracts the oxygen from the phosphoric acid of the superphosphate, setting free the phosphorus, which is volatilised, and condensed in water contained in a copper receiver. It is afterwards purified by pressing it through shamoy leather under water. It is subsequently moulded for sale into cylinders, by melting it in water, and sucking it up a slightly conical glass tube, which is then immersed in cold water, when the solidified stick of phosphorus falls out.[2] Another mode of giving the stick form to phosphorus has been suggested by Seubert.[3] It consists in letting melted phosphorus flow into horizontal glass tubes, one extremity of each tube being surrounded by warm water (111° Fahr.) the other by cold water. The phosphorus when solid is removed from the tube, and thus makes room for a fresh supply, which again solidifies, and thus a stick of any length may be formed.

---

[1] De Candolle, *Phys. Végét.* pp. 383, 387, and 390.

[2] For further details, consult Soubeiran, *Nouveau Traité de Pharmacie*, t. ii. p. 260, 2de édit.; also Ure, *Dict. of Arts.*

[3] *Pharmaceutical Journal*, vol. iv. p. 129.

Wöhler[1] obtained phosphorus by distilling two parts of bone black with one of quartz sand at a white heat. The silicic acid of the sand decomposed the phosphate of lime contained in the bone black, and disengaged the phosphoric acid which was de-oxidised by the carbon.

PROPERTIES.—It is colourless, and when it has been solidified slowly it is transparent; but when rapidly, it is cloudy, and has a waxy lustre. It crystallises in regular octohedrons and rhombic dodecahedrons. Its sp. gr. is 1·896. At 32° F. it is brittle, but at ordinary temperatures is somewhat flexible. At 94° it is very brittle, and may be easily pulverised; at 110° F. it melts, and forms an oily-like liquid. At 482°, Heinrich (550°, Dalton; 574°, Pelletier), it boils, and yields a colourless vapour whose sp. gr., according to Dumas, is 4·355. Both solid and liquid phosphorus is a non-conductor of electricity. At ordinary temperatures it evolves a small quantity of vapour. In the atmosphere its fumes are luminous in the dark, in consequence of slow combustion, and they have the odour of garlic. Phosphorus is insoluble in water, but soluble in ether and in the oils both fixed and volatile.

Phosphorus assumes the allotropic state, becoming of a red colour. This red substance was formerly regarded as a sub-oxide of phosphorus (see *ante*, p. 231).

Preservation. — Phosphorus should be preserved in a stoppered vessel filled with water and kept in the dark (as inclosed in a tin box).

Granulation.—Phosphorus may be granulated by melting it under water and shaking it in a closed vessel until it is cold. According to Casaseca,[2] proof spirit is better than water for this purpose. Böttger states that human urine, or an artificial solution of urea, succeeds best. He half filled a tall cylindrical vessel of half an inch wide with this fluid, heated it to the melting point of phosphorus, divided this for two minutes by means of a whisk (*Quirl*), which passed through a wooden lid, and during the agitation filled up the vessel with cold water.

VARIETIES.—In the text, phosphorus is described as being colourless and transparent, or nearly so. In commerce, however, it is frequently met with coloured and opake.

1. *Yellow or red phosphorus.*—Commercial phosphorus is frequently of a yellow, pale buff, or reddish colour, in consequence of its assuming the allotropic state.

2. *White phosphorus.*—Phosphorus kept under water and exposed to diffused daylight acquires a white opake coating. Different opinions exist as to the nature of this crust. Rose considers it to be merely phosphorus in a different state of aggregation. Pelouze regards it as a *hydrate of phosphorus*, P^2,HO. Mulder considered it was a compound of the red oxide of phosphorus (allotropic phosphorus) and phosphuretted hydrogen.

3. *Black phosphorus.*—If phosphorus be heated to 140° F. or 158° F., and then suddenly cooled to 32°, it sometimes becomes black. Thenard, who first observed this phenomenon, found that all kinds of phosphorus do not undergo this change, but only that which has been repeatedly distilled.—Dumas speaks of a blackish phosphorus which distils over towards the end of the process in making phosphorus; and he says that it is usually supposed to be combined with carbon, but he thinks that it is more probably with silicium.—The black French phosphorus described by Wittstock[3] contained arsenic, bismuth, lead, iron, copper, and especially much antimony. It yielded by solution in sulphuret of carbon brown flocculi of sulphuret of antimony.

Characteristics.—Phosphorus, in substance, is easily recognised by its waxy appearance and garlic-like odour; by its fuming in the air, and being phosphorescent or luminous in the dark; by friction or gentle heat causing it to inflame; and, lastly, by its burning with a most intense white light and a white smoke (phosphoric acid) in air, or still better in oxygen gas. A solution of phosphorus in oil or ether may be known by its garlick-like odour, and, when rubbed on the skin, by its rendering the latter luminous in the dark. When boiled in nitric acid phosphorus is converted into phosphoric acid, the characteristics of which will be given hereafter.

---

[1] Poggendorff's *Annalen*, xvii. 178, 1829.

[2] *Journ. de Pharmacie*, xvi. 202.

[3] *Berl. Jahrb. für d. Pharmacie*, Bd. xxxiii. Abt. ii. p. 146, 1833.

IMPURITIES.—The best phosphorus is colourless, transparent, or only slightly cloudy, and breaks with a short crystalline fracture.

Dumas appears to regard flexibility as a characteristic of good phosphorus: for he says that the same stick may be bent seven or eight times in different directions without breaking; but, he adds, the addition of $\frac{3}{60}$ths of sulphur is sufficient to render it brittle. [Dumas's test of flexibility is, however, materially dependent on the temperature at which the experiment is made.—ED.]

Commercial phosphorus sometimes contains sulphur or arsenic,[1] or both. Wittstock obtained 3·654 grains of metallic arsenic from one ounce of phosphorus:—equal to 0·761 per cent. Occasionally, also, it contains antimony, and some other metals above noticed. Probably all these impurities are derived from the sulphuric acid employed in decomposing the bone ash. When this acid has been prepared from arsenical pyrites it contains arsenious acid, which becomes reduced in the process for making phosphorus; and Wittstock suggests that the black phosphorus which he found to contain antimony, &c. had been prepared with oil of vitriol made with native sulphuret of antimony.

Detection.—A solution of pure phosphorus in diluted nitric acid yields, with a solution of barytic salt, a precipitate which is soluble in excess of nitric acid. But if phosphorus yield a precipitate insoluble in this acid, the presence of sulphuric acid (formed by the oxidation of sulphur) may be inferred.

The presence of arsenic in phosphorus may be detected as follows:—Convert the phosphorus into phosphoric acid by boiling in nitric acid; dilute the solution with water, and transmit sulphuretted hydrogen through it; if arsenic be present, a yellow precipitate is obtained.—By evaporating a solution of phosphorus in dilute nitric acid, a blackish arsenical deposit is obtained: the phosphorous acid contained in the solution deoxidizes the arsenic.

Purification.—Redistillation will not deprive phosphorus of its contained arsenic. By repeated digestion in diluted nitric acid, the greater part, or the whole, of it may be removed. Wöhler[2] says that opake yellow or red phosphorus may be rendered transparent and colourless by melting it in a concentrated solution of bichromate of potash to which sulphuric acid has been added. The vessel should be stoppered, and shaken strongly to divide the phosphorus into fine globules.

PHYSIOLOGICAL EFFECTS. α. *On Vegetables.*—According to Marcet it is poisonous to plants.

β. *On Animals generally.*—Water impregnated with phosphorus acts as an aphrodisiac to drakes.[3] Phosphuretted oil is a stimulant to horses: blood drawn from the veins of horses under its influence has a phosphoric odour.[1] If phosphuretted oil be injected into the jugular vein, or into the cavity of the pleura of a dog, white vapours of phosphorus are evolved from the mouth, and death shortly takes place. The phosphorous acid (formed by the combustion of the phosphorus) inflames the lungs in its passage through the delicate pulmonary vessels. Introduced into the stomach of animals, phosphorus acts as a caustic poison. The corrosion is supposed to depend on the action of the phosphorous acid (formed by the combination of the phosphorus with the oxygen of the air contained in the pulmonary canal) on the tissue with which it is in contact.[2]

---

[1] Baerwald, *Berl. Jahrb. für d. Pharmacie*, Bd. xxxiii. Abt. ii. p. 113, 1833; also Wittstock, *ibid.* p. 125.

[2] *Ann. der Chem. u. Pharm.* Bd. xlv. p. 249, 1843.

[3] Alph. Leroy, quoted by Bayle, *Biblioth. de Thérap.* t. ii. p. 28, Paris, 1830.

γ. *On Man.*—The general stimulant operation of phosphorus has been already alluded to (see *ante*, p. 232), as well as its chemical action (see *ante*, p. 97). In *small doses* phosphorus excites the nervous, vascular, and secreting organs. It creates an agreeable feeling of warmth at the epigastrium, increases the frequency and fulness of the pulse, augments the heat of skin, heightens the mental activity and the muscular powers, and operates as a powerful sudorific and diuretic. Its aphrodisiac operation has been recognised by Alphonse Leroy and Bouttatz,[3] by experiments made on themselves; and the facts collected by Dr. Hartcop bear out this statement (Dr. A. Taylor). In *somewhat larger doses*, it causes burning pain, vomiting, and purging, with extreme sensibility of the stomach which lasts for several days.[4] In *still larger doses*, it causes inflammation of the stomach and bowels. Its activity as a caustic poison depends, according to Orfila, on its absorbing oxygen, and thus becoming converted into an acid which acts as a corrosive, like the other mineral acids. Hence, therefore, ethereal and oleaginous solutions are more active poisons, inasmuch as the oxidation of the phosphorus is effected more rapidly. Comparatively small doses have in some cases proved fatal. Dr. Christison[5] mentions one instance in which 1½ grains, in another instance 3 grains, caused death.[6] Cases, however, are reported, in which 6, 10, and even 12 grains have been swallowed without any hurtful effects; but doubts have been entertained as to the correctness of the statements. Thus Mérat and De Lens[7] think that the phosphorus employed in these cases must have undergone some chemical change. I once administered 16 grains of apparently good phosphorus to a man without any injurious effect. The person here alluded to was Chabert, some years ago renowned in London under the name of the "*Fire King.*" I carefully weighed the above quantity, which was placed in a spoon, introduced into his mouth, and washed down by a tumblerful of water. He offered to take this dose daily. Within ten minutes after swallowing the phosphorus, he left the room for about a quarter of an hour.

A case of suspected poisoning by phosphorus administered medicinally is reported by Mr. Reedal:[8] but the total amount of phosphorus which was taken is not stated; and it is by no means certain that the death was owing to it. Post-mortem examination shewed the existence of inflammation of the cæcum and colon.

---

[1] Pilger, quoted by Bayle.

[2] Orfila, *Toxicol. Génér.*

[3] Bayle, *op. cit.*

[4] See an experiment made by Sundelin on himself, *Handb. der Heilmittellehre*, Bd. ii. S. 213.

[5] *Treatise on Poisons.*

[6] In the *Morning Herald* of June 17, 1840, is a report of an inquest held on the body of a child killed by sucking the phosphoric ends of lucifer matches.

[7] *Dictionnaire de Matière Médicale.*

[8] *Lancet*, Sept. 14, 1844, p. 754.

During the last three years, the attention of the profession in Germany, France, and England,[1] has been drawn to the occasional occurrence of necrosis of the jaw-bone in work-people engaged in the manufacture of lucifer and congreve matches. The disease, which is avoided by using phosphorus in its allotropic state (*ante*, p. 231), appears to be a secondary consequence of periostitis, which is probably produced by the fumes from phosphorus employed in the above manufacture; though by some it has been referred to rheumatism, and by others to arsenic,[2] with which the phosphorus has been found, in some cases, to be contaminated. Neither of the latter assumed causes, however, are sufficient to account for it. Rheumatic invalids and arsenic-smelters are not liable to disease of this kind.[3] We may therefore assume that the phosphoric fumes are the cause of it. Now these consist in part, perhaps, of phosphorus vapour, but chiefly of phosphorus in combination with oxygen. When in high or brilliant combustion (which often occurs in the lucifer match manufactories), phosphorus yields phosphoric acid (PO^5); but, by slow combustion, the chief product is phosphorus acid (PO^3), which becomes converted into phosphoric acid by the absorption of oxygen. According to Dr. von Bibra,[4] hypophosphorous acid is produced by the oxidation of the vapour of phosphorus.

Strohl,[5] Roussel, and some others, consider the phosphoric acid to be the agent producing the disease; but it is stated[6] that, in phosphorus manufactories, in which the atmosphere is impregnated with phosphoric acid, no disease of the kind is produced; and, therefore, by some the malady is ascribed to a compound having a lower degree of oxidation. Dr. von Bibra refers it to hypophosphorous acid, but lays great stress on the fact that Schönbein's ozone is formed during the volatilization of phosphorus.

The jaw disease is presumed to be a local malady produced by the direct action of the fumes on the jaw-bone. For toothache and caries of the teeth are said to have existed prior to the affection of the bone; and it is to be inferred, that if the disease were a constitutional one, and due to the absorption of the poison, that probably other bones would also become affected. Moreover, Dr. von Bibra found in his experiments on rabbits, that unless the jaw bone was exposed to the vapours, that the disease was not produced. Dr. Lorinser, on the contrary, thinks that the poison acts through the blood; and states that individuals under its influence have a peculiar sallow, bloated complexion, combined with a dull expression of the eye and gastric derangement.[1] I have myself observed this remarkable appearance of the countenance in the dipper of a congreve match manufactory, whose jaws, however, were quite sound. The best preventives of the phosphorus jaw disease have been good ventilation of the rooms of the manufactory, and personal cleanliness. Mr. Hynam, an extensive manufacturer of congreve matches in Princes Street, Finsbury Square, tells me that no case of this malady has ever occurred among his numerous work-people, some of whom have worked there for seven, eight, or even ten years. Their freedom from the disease he ascribes to good ventilation and personal cleanliness. The dippers wear sponges before their mouths; and all the work-people employ a solution of soda[2] for washing their hands. It has been lately proposed to substitute allotropic for common phosphorus. The more fixed nature of allotropic phosphorus would, it is considered, have the effect of preventing the occurrence of the phosphoric disease.

---

[1] In this country, the phosphorus jaw-disease does not appear to have been frequently met with. A case is reported in the *Guy's Hospital Reports* for April 1846 to March 1847, p. 163. Two cases have occurred at the London Hospital.

[2] Dupasquier, *Comptes Rendus*, t. xxiii. p. 454, 1846; and *Journ. de Pharmacie*, t. x. 3e sér. p. 284, 1846; also Chevallier, *Comptes Rendus*, t. xxiii. p. 635, 1846.

[3] Roussel (*Comptes Rendus*, t. xxii. p. 292, Feb. 16, 1846) has shown, that the effects of arsenic have nothing in common with those produced by phosphorus.

[4] *Die Krankheiten der Arbeiter in den Phosphorzündholzfabriken, ins besondere das Leiden der Kieferknochen durch Phosphordämpfe, vom chemischphysiologischen, medicinischchirurgischen und medicinischpolizeilichen Standpunkte*, bearbeitet von Dr. Fr. Ernst von Bibra und Dr. L. Geist, mit neun gemalten Kupfertafeln, Erlangen, 1847.

[5] *Gaz. Méd. de Strasbourg*, Nov. 1845; also, *American Journal of the Medical Sciences*, new series, vol. xii. p. 525, Oct. 1846.

[6] *British and Foreign Med.-Chir. Rev.* April 1848, p. 454.

Another effect of the phosphorus fumes is irritation of the conjunctiva and of the mucous membrane lining the air passages. Bronchial irritation has been especially noticed by the French writers.[3] In this country, catarrhal and pulmonary affections have been ascribed to the action of these fumes.[4]

USES.—In this country, phosphorus is rarely employed, and therefore it will be unnecessary to enter minutely into its uses. It has been strongly recommended in those cases attended with great prostration of the vital powers, as in the latter stages of typhus fever, dropsies, &c.; in some chronic diseases of the nervous system (as epilepsy, paralysis, melancholy, mania, amaurosis, &c.) occurring in debilitated subjects. In some of the exanthemata, as measles, it has been administered to promote the re-appearance of the eruption, when this, from some cause, has receded from the skin. In *impotentia virilis* of old and debilitated subjects, in cholera, and in some other maladies, it has also been exhibited. Paillard recommends phosphorus as a caustic, in the place of moxa, than which, he says, it is more convenient and safe.[5]

ADMINISTRATION.—Phosphorus cannot be given with safety in the solid form. It may be administered dissolved in ether, or, still better, in oil.

ANTIDOTES.—In poisoning by phosphorus, large quantities of mild demulcent liquids are to be exhibited, so as to envelope the phosphorus and exclude it from the air contained in the alimentary canal. Magnesia should be given, in order to neutralise the phosphorous and phosphoric acids which may be formed. Parts burned with phosphorus are to be washed with a weak alkaline solution, to remove any adherent acid which might serve to keep up irritation.

1. TINCTURA PHOSPHORI ÆTHEREA; *Tinctura Ætherea cum Phosphoro,* French Codex; *Ethereal Tincture of Phosphorus.* (Phosphorus 4 parts, Sulphuric Ether 200 parts by weight. Macerate for a month, in a well-stoppered bottle covered with black paper, occasionally shaking. Preserve it in small bottles, well stoppered and covered with black paper).—The quantity of phosphorus dissolved is about 4 grains for each ounce of ether. Dose from 5 to 10 drops. Some objection has been raised to the use of this preparation, on the ground that, by the evaporation of the ether, the phosphorus will be set free in the stomach, and might ignite.

---

[1] I have already (see *ante*, p. 231) noticed the unusual quantity of phosphoric acid found by Dr. Letheby in the urine.

[2] The Austrian Government, at the suggestion of a commission appointed to inquire into its origin, ordered the girls employed in the lucifer-match manufacture to wash their mouths well with acidulated water!! (Dr. Balfour, *Northern Journal of Medicine,* vol. iv. p. 286, 1846; and *Lancet*, Aug. 29, 1846)

[3] See Gendrin, in Roussel's *Mémoire*, before referred to; and Dupasquier, *ante cit.*

[4] *London Medical Gazette*, vol. xxxix. p. 210; and *Medical Times*, Dec. 18, 1846, p. 224

[5] *Ibid.* vol. ii. p. 254.

2. OLEUM PHOSPHORATUM, Ph. Borussica; *Phosphorated Oil.* (Phosphorus dry and cut into small pieces, gr. xij.; Almond Oil, recently prepared, ℥j. Melt the phosphorus in the oil by the aid of warm water: then agitate until it appears to be dissolved).—One ounce of oil dissolves about four grains of phosphorus. Dose from 5 to 10 drops. It should be administered in some mucilaginous liquid, or made into an emulsion. It may be aromatised by a few drops of some essential oil, as of bergamot.

[The London College notice phosphorus in their Pharmacopœia for 1851, placing it in the Materia Medica with the following note:—"Nearly colourless, resembling wax, transparent; it gives out light in the dark. It should be kept in water, and shut out from access of light."—Ed.]

9. ACIDUM PHOSPHORICUM.—PHOSPHORIC ACID.

Formula PO^5. *Equivalent Weight* 72.

History.—Phosphoric acid was first distinguished by Marggraf, in 1740.

This acid is susceptible of three modifications, designated as *metaphosphoric acid* ($a\ PO^5$), *pyrophosphoric acid* ($b\ PO^5$), and *common phosphoric acid* ($c\ PO^5$). The first combines with *one*, the second with *two*, the third with *three* atoms of water or base: hence the first is denominated *monobasic*, the second *bibasic*, the third *tribasic* phosphoric acid. For an admirable account of these modifications we are indebted to Professor Graham.[1]

Natural History.—Phosphoric acid occurs both in the inorganised and organised kingdoms (see *ante*, pp. 340).

All the phosphoric salts of the mineral kingdom contain the common or tribasic phosphoric acid.[2]

Preparation.—A watery solution of common or tribasic phosphoric acid ($c\ PO^5$) is the only modification of phosphoric acid employed in medicine.

In the London Pharmacopœia, diluted phosphoric acid (*acidum phosphoricum dilutum*) is ordered to be thus prepared:—

Take of Phosphorus, ʒvj.; Nitric Acid, f℥iv.; Distilled Water, f℥viij. Add the phosphorus to the nitric acid, mixed with the water, in a retort placed in a sand bath; then apply heat until six fluidounces are distilled. Let these be again put into the retort that six fluidounces may distil, which are to be rejected. Evaporate the remaining liquor in a platinum capsule until only two ounces remain. Lastly, add to the acid, when it is cold, as much distilled water as may make it accurately fill a pint measure, and mix.

By the mutual action of phosphorus and dilute nitric acid, phosphorous acid (PO^3), as well as phosphoric acid (cPO^5), is produced, while binoxide of nitrogen is evolved. The formation of phosphorous acid may be accounted for by the mutual reaction of three equivalents of nitric acid and three equivalents of phosphorus: $3P+3NO^5=3PO^3+3NO^2$. Phosphoric acid is formed by the action of three equivalents of phosphorus on five of nitric acid: $3P+5NO^5=3cPO^5+5NO^2$.

---

[1] *Philosophical Transactions* for 1833.

[2] Boussingault, *Ann. Chim. Phys.* t. lv. p. 185, 1833.

MATERIALS.		COMPOSITION.		PRODUCTS.	
5 eq. Nitric Acid ...	270	5 *eq. Nitrogen* 10 *eq. Oxygen*... 15 *eq. Oxygen*...	70 80 120	5 eq. Binox. Nitrogen...	150
3 eq. Phosphorus ...	96	....		3 eq. Phosphoric Acid .	216
	366				366

If strong nitric acid be employed, instead of the dilute acid ordered in the Pharmacopœia, the reaction is so energetic that explosion and combustion are sometimes the consequence. In such cases, some nitrate of ammonia is usually developed: the ammonia being formed by the union of the nitrogen of the acid with the hydrogen of the water.

By concentrating the solution of phosphorous and phosphoric acid, the phosphorous acid is converted into phosphoric acid by the free nitric acid present: $3PO^3+2NO^5=3PO^5+2NO^2$. The excess of nitric acid is driven off by evaporation.

PROPERTIES.—The aqueous solution of phosphoric acid (*acidum phosphoricum dilutum*, Ph. L.) prepared as above, is a colourless and odourless liquid. It possesses the usual characteristics of an acid; that is, it is sour to the taste, reddens litmus, and neutralizes bases. Its sp. gr., according to the London Pharmacopœia, is 1·064. By evaporation it acquires the consistence of treacle (*hydrated phosphoric acid*); and when exposed to a higher temperature it loses water and becomes *pyrophosphoric acid* ($2HO, PO^5$). At a dull red heat a further evolution of water takes place, and a compound is formed, called *metaphosphoric acid* (HO, PO^5); this is fusible, and, by cooling, concretes into a transparent solid, called *glacial phosphoric acid*.

Characteristics.—If the common or tribasic phosphoric acid be saturated with an alkali (soda) so as to form a soluble phosphate, it may be distinguished from all other acids by the following characters:—it throws down, with the soluble salts of lime, lead, and baryta, white precipitates (*phosphates*), soluble in nitric acid. If the phosphate of lead ($3PbO, cPO^5$) (thrown down by a soluble salt of lead) be heated in the oxidizing flame of the blowpipe, it yields a colourless and transparent button, which turns opaque and crystalline on cooling. Nitrate of silver yields with the common phosphate a light yellow precipitate (*tribasic phosphate of silver*, $3AgO, cPO^5$), soluble both in nitric acid and ammonia. Sesquichloride of iron added to the solution of alkaline phosphate, causes a white gelatinous precipitate (*perphosphate of iron*) insoluble in acetic acid. Hydrosulphuric acid produces neither change of colour nor precipitate in a solution of phosphoric acid or phosphate.

Pyrophosphoric acid causes, with a solution of nitrate of silver, a white precipitate (*pyrophosphate of silver*=$2AgO,bPO^5$), but with either chloride of barium or solution of albumen no precipitate.

Metaphosphoric acid causes a white precipitate (*malaphosphate of silver*=AgO,aPO^5) with nitrate of silver, and also a white precipitate, with chloride of barium and with a solution of albumen.

PURITY.—The following are the qualities of this preparation, as given in the London Pharmacopœia:—

"Free of colour and odour. Specific gravity, 1·064. Nothing is thrown down on the addition either of chloride of barium or nitrate of silver. Copper and silver foils in no way affect it; nor is it coloured by hydrosulphuric acid either before or after their immersion in it. A fluidounce of this acid is saturated by 132 grains of crystals of carbonate of soda, and nothing is thrown down by it."

The chloride of barium is to detect *sulphuric* acid: while the nitrate of silver detects *hydrochloric* acid. Should any free *nitric* acid be present, a portion of the copper and silver would be dissolved, with, on the application of heat, the evolution of binoxide of nitrogen; and the solution would yield a dark precipitate with hydrosulphuric acid. Moreover, if the liquid contains nitric acid, it will, by the aid of heat, decolorize a solution of indigo; and when supersaturated with lime, filtered, and evaporated, yield nitrate of lime. If *phosphorous acid* be present, the solution will yield a precipitate of calomel on the addition of excess of bichloride of mercury; and a black precipitate on the addition of protonitrate of mercury. Should the liquid contain *arsenious acid*, a yellow precipitate (*orpiment*, AsS^3) is obtained when sulphuretted hydrogen is transmitted through it. If *arsenic acid* be present, the acid liquid yields, when saturated with sulphuretted hydrogen and preserved in a stoppered bottle for a day or two, a light yellow precipitate (*persulphuret of arsenic*, AsS^5); but if sulphurous acid be added and heat applied, so as to convert the arsenic into arsenious acid, sulphuretted hydrogen produces immediately a yellow precipitate (*orpiment*, AsS^3).

The quantity of carbonate of soda which, according to the Pharmacopœia, the acid is capable of saturating, indicates the per centage strength to be 8.7.[1] The absence of any precipitate, on the addition of carbonate of soda, shows that no phosphate of lime or any other earthy phosphate is present.

Composition.—Pure anhydrous phosphoric acid is thus composed:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Berzelius.*	*Dulong.*	*Davy.*
Phosphorus	1	32	44·44	43·936	44·923	42·6
Oxygen	5	40	55·55	56·064	55·077	57·4
Phosphoric acid	1	72	100·00	100·000	100·000	100·0

Mr. Phillips gives the composition of the dilute acid as follows:—

Phosphoric acid	8·7
Water	91·3
	100·00

Physiological Effects. *a. On Vegetables.*—This acid is poisonous to plants.[2]

β. On Animals.—Very few experiments have hitherto been made with it on animals. Orfila[3] found that a strong solution of it acted like sulphuric acid. Thrown into the veins of a dog, it coagulated the blood, and killed the animal within ten minutes. Introduced into the stomach, it acted as a powerfully corrosive poison.

γ. On Man.—Diluted phosphoric acid produces the usual effects of the diluted mineral acids, and which I have before noticed (p. 174). It is milder, more assimilable, and therefore less likely to disagree with the digestive organs than sulphuric acid, with which, in its action, it is usually compared. These qualities it perhaps derives from its being, as Burdach[1] expresses it, "less heterogeneous to the human organism, since it has a considerable share in the composition of it." The same authority also observes, that besides fulfilling the indications of the mineral acids, "it much exalts the excitability when the organism is weak."

---

[1] Phillips's *Translation of the London Pharmacopœia*, p. 71, 1851.

[2] Gœppert, quoted by Decandolle, *Phys. Végét.*

[3] *Toxicol. Génér.*

Various effects have been ascribed to this acid, which require to be further investigated ere they are admitted. Thus Hecker[2] says, it exerts a special influence over the nervous system, in virtue of which it possesses the power of allaying pain and spasm. Lentin[3] considers it to be endowed with the specific power of influencing surfaces and bones, whereby it is enabled to ameliorate various morbid conditions of these parts. Sundelin[4] regards it as a stimulant and tonic to the sexual organs.[5] Various effects have been ascribed to it by Herder.[6]

PHOSPHOROUS ACID.—This acid possesses poisonous properties. Wöhler and Frerichs[7] state, that phosphorus agrees with arsenic in its effects on living beings, in the circumstance that its lower oxide (*e. g.* phosphorous acid) is more injurious than the highest (phosphoric acid). Their experiments do not, however, confirm those made by Weigel and Klug in 1844, in which it was observed that phosphorous acid produced inflammatory swellings of the mucous membrane of the stomach, while phosphoric acid did not. The importance of using phosphoric acid free from phosphorous acid is, however, well established.

USES.—Phosphoric acid has been employed in the same cases in which sulphuric and other mineral acids have been used, and under the same regulations. It may be employed for a longer period, without disturbing the digestive functions, than the other agents of this class.

It has been used in certain cases rather on theoretical than practical grounds. Thus its power of dissolving phosphate of lime has led to its employment in those forms of lithiasis attended with phosphatic deposits in the urine (see foot-note at p. 177), in ossification of the arteries and cardiac valves, and in exostosis and other osseous tumours. Lentin used it as a local agent to check caries, from a notion that this disease depends on a deficiency of phosphoric acid in the part affected. Woulff applied it to promote the formation of bone.

There are several other diseases against which this acid has been administered. Thus it has been given in blenorrhœa and leucorrhœa, when the secreted fluid was thin and acrid (Sundelin),—in profuse suppuration, to diminish the quantity and improve the quality of the secreted matter,—Sundelin has found it useful in hysterical affections of young and irritable subjects,—in impotency of the male (Berends),—in diabetes,—and in jaundice. Dr. Paris[8] has found it to assuage the thirst so commonly present in diabetes, more effectually than any other acidulated drink.

ADMINISTRATION.—Internally, the dilute phosphoric acid should be given in doses of from twenty minims to a fluidrachm, properly diluted. Mixed with eight or ten times its volume of water, it may be employed as a wash in caries.

---

[1] *Arzneimittellehre*, Bd. iii. S. 395, 1809.

[2] *Ibid.* Bd. ii. S. 305.

[3] *Beitrage zur ausüb. Heilk.* Bd. ii. S. 139.

[4] *Heilmittellehre*, Bd. ii. S. 234.

[5] Dupasquier states, that the workpeople exposed to the phosphoric fumes in lucifer-match manufactories do not appear to experience sexual excitement therefrom.

[6] *Hufeland's Journal*, Bd. ix. St. iii. S. 148.

[7] *Chemical Gazette*, June 15, 1848.

[8] *Appendix to the Eighth Edition of the Pharmacologia*, London, 1836.

Antidotes.—(See *Sulphuric Acid.*)

Order VI. SULPHUR AND ITS COMPOUNDS WITH OXYGEN, HYDROGEN, AND CARBON.

10. SULPHUR.—SULPHUR OR BRIMSTONE.

Symbol S. *Equivalent Weight* 16. *Equivalent Volume of Sulphur Vapour* 0·16 or ▭

History.—Sulphur (from *sal*, and πῦρ, *fire*) has been known from the most remote periods of antiquity. It is mentioned by Moses,[1] Homer,[2] and other ancient writers. The word *brimstone* (*brynston*, as written by Piers Ploughman) signifies *brennestone*, or *burn-stone*.

Natural History.—It is found in both kingdoms of nature.

a. In the Inorganised Kingdom.—*Native* or *virgin sulphur* occurs in two forms: either imbedded in rocks (*common native sulphur*), or produced by sublimation (*volcanic sulphur*). In Sicily[3] it is found in beds in a blue clay formation, which, in the opinion of Dr. Daubeny, is more recent than chalk, but is of the same age with the gypsum beds in the neighbourhood of Paris. Solfatara (called by the ancients *Forum Vulcani*, or the *Court of Vulcan*), a kind of half-extinct volcano (derived from the Italian Zolfo-terra, sulphur-earth) in the vicinity of Naples, is celebrated for its native sulphur, which is collected in considerable quantities for the purpose of commerce.[4] Sulphur is also found in the mineral kingdom in a state of combination, as in the various forms of pyrites. Thus sulphurous acid gas is evolved by volcanoes. Sulphuric acid is found native both in the free and combined states. [Sulphuric acid has been detected in the air and water of towns by Dr. R. A. Smith, who examined rain water obtained at Manchester. He found it usually associated with ammonia. Such water, though alkaline (from carbonate of ammonia) before evaporation, became strongly acid when concentrated.[5]—Ed.] Hydrosulphuric acid gas is evolved from the pure sulphurous or hepatic waters and from the soil in some other places: lastly, sulphur is found in combination with metals.

β. In the Organised Kingdom.—Sulphur is found both in animals and plants. Thus it is a constituent of albuminous or protein substances (see *ante*, p. 63), of the allyle oils (see *ante*, p. 225), of cystic oxide (see *ante*, p. 275), of urine, &c.

Preparation.—Sulphur is procured in two ways: by the purification of native sulphur, or by the decomposition of the native sulphurets. The sulphur of British commerce is almost exclusively obtained in the first way. It is brought principally from Sicily.

α Purification of native sulphur.—In Sicily, the native sulphur is submitted to a rude process of fusion: it is collected in heaps, which are set fire to on the surface: the heat developed by the combustion of one portion fuses another.[6]

---

[1] *Genesis*, xix. 24.

[2] *Iliad*, lib. xvi.

[3] Some mineralogists entertain the opinion, that Sicilian sulphur is of organic (animal) origin.—See *Athenæum* for Dec. 8, 1838; also Leonhard, *Handbuch der Oryktognosie*, S. 599, Heidel. 1826.

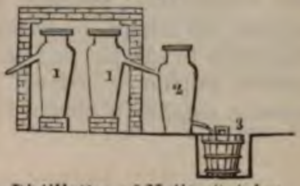
[4] Sir W. Hamilton's *Campi Phlegræi*, 1776.

[5] *Pharmaceutical Journal*, vol. xi. p. 173.

[6] Daubeny, *Description of Volcanoes*, p. 197.

Another mode of extracting sulphur is by distillation in earthen pots in a *furnace gallery*. These are arranged in two rows in a large oblong furnace, fig. 53 (1, 1), the top of each pot, which serves for the introduction of the sulphur for the removal of the residuum, being kept closed during the operation. The upper and lateral part of each pot communicates with an inclined tube of about two inches diameter and fourteen long. When the fire is lighted in the furnace, the sulphur fuses and sublimes, and passes through this tube into another pot (2), placed on the outside of the furnace, and perforated near its bottom to allow the melted sulphur to flow into a pail (3) containing water, where it congeals, and forms *rough* or *crude sulphur*.[1]

FIG. 53.



Distillation of Native Sulphur.

β. Decomposition of metallic sulphurets.—In some places sulphur is procured by the decomposition of metallic sulphurets (of iron and copper) by heat. This is effected in various ways. At Ramelsberg, and some other places, pyrites are heated or torrefied in pyarmidal heaps (*Rösthaufen*) covered by earth. The sulphur is partly burnt and converted into sulphurous acid, and partly volatilized to the bottom of the truncated pyramid, where it is condensed in cavities made for the purpose, and from which it is removed from time to time in ladles.[2] Another method consists in roasting the pyrites in chambers or ovens (*Röstöfen*).[3] This is the method adopted at the Parys mine in Anglesea. The copper pyrites are roasted, by which part of the sulphur is burned, while the remainder is volatilized and collected in chambers connected with the domes of the furnaces by means of horizontal flues.[4] A third method, employed in Saxony and Bohemia, consists in submitting pyrites to heat in earthen tubes placed in a furnace gallery. The sulphur is condensed in a receiver containing water.[5] By this process common iron pyrites (FeS^2) is deprived of an atom of sulphur, and the residual sulphuret (FeS), called *Schwefelbrände*, is used for making green vitriol (L. Gmelin).

PROPERTIES OF CRUDE SULPHUR.—Crude or rough sulphur (*sulphur crudum*) is imported into England chiefly from Sicily. Of 507,808 cwt. imported in 1834, 485,756 cwt. came from Sicily (M'Culloch). It comes over in irregular blocks or masses, whose colour is somewhat paler than that of refined sulphur. Fine Sicilian sulphur contains not more than 3 per cent. of foreign matter, chiefly earthy, but not at all arsenical (Ure).

[The quantity of sulphur imported has increased greatly since 1834. Thus, during 1853, 921,868 cwt. were received into England, and the quantities quoted for 1852 and 1851 are within 8 cwt. of that for 1853.—ED.]

Vauquelin[6] distilled 200 grains of rough sulphur, and obtained a residuum of 0·82, composed of silica, carbonate of lime, iron, bituminous charcoal, alumina, and magnesia; but the proportion of earthy matter is generally more considerable. Sulphur obtained from pyrites usually contains orpiment (AsS^3).

---

[1] Dumas, *Traité de Chimie*, t. i. p. 121.

[2] C. A. Schlüter, *Grundl. Unterricht von Hütte-werken*, Braunschweig, 1738; and Chaptal's *Elements of Chemistry*, vol. i. p. 93, London, 1791.

[3] Ferber, quoted by L. Gmelin, i. 600.

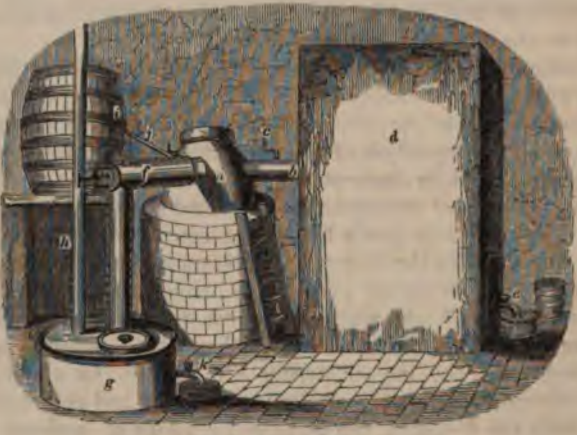
[4] Aikin's *Dictionary of Chemistry*, vol. ii. art. *Sulphur*, p. 352.

[5] Dumas, *Traité de Chimie*, t. i. p. 132, Paris, 1828.

[6] *Ann. de Chim.* xxv. 50.

REFINING.—There are three modes of refining sulphur: viz. first, fusion and decantation; secondly, distillation; thirdly, sublimation. Formerly, sulphur was refined by fusing it in an iron cauldron, allowing the earthy impurities to subside, and ladling out the supernatant liquid sulphur. At present, sulphur is refined by distillation and sublimation: by distillation, *massive sulphur* is obtained; by sublimation, *flowers of sulphur*.

FIG. 54.



Distillation of Sulphur.

a. Cast-iron still.
b. Communication between the still and the sulphur chamber (*d*).
c. Handle by which this communication can be shut off.
e. Vent pipe, one end of which opens into the chamber, the other dips into water.
f. Communication between the still and the receiver (*g*).
h. Vent pipe.
i. Water butt, which supplies cold water by the pipe *j*, to cool the distilled sulphur, and afterwards runs off at *k*.

For this purpose crude sulphur is put into an iron pot (fig. 54), set in brick work, over a proper fire. To this is adapted an iron head (*a*), removable by a crane, and communicating by two tubes or necks (*b* and *f*), the one with the sulphur chamber (*d*), the other with the iron receiver (*g*), which is immersed in water. The communication (*f*) between the still and the receiver being shut off, the sulphur distils into the sulphur chamber (*d*), on the walls of which it is deposited in a pulverulent form. When obtained in this state, it is called *flowers of sulphur*. The door into this chamber is placed near the ground, and is closed when the process is going on. If the communication (*b*) between the still and the sulphur chamber be shut off by turning the handle (*c*), and the communication (*f*) between the still and the receiver (*g*) opened, the sulphur distils over and condenses into a liquid which, when solidified, constitutes the *refined sulphur* of commerce. The elbow-pipe, which forms the communication between the still and the receiver, is encased in a metal jacket, between which and the tube a current of cold water is continually flowing from the butt(*i*), and, after passing around the receiver (*g*), escapes at *k*. The top of the receiver is perforated by a vent pipe (*h*), and is supplied with a circular aperture, by which the liquid sulphur can be ladled out, but which is usually kept closed by a movable lid.

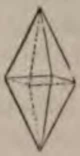
PROPERTIES.—Refined sulphur occurs in two forms in commerce:—

1st. *Massive*, either in lumps or in sticks. The former is called *lump sulphur;* the latter *stick, roll*, or *cane sulphur* (*sulphur in baculis; sulphur in rotulis; sulphur rotundum; sulphur citrinum*).

2dly. *Pulverulent*, called *sublimed sulphur* (*sulphur sublimatum*), or *flowers of sulphur* (*flores sulphuris*).

Solid sulphur may be either crystalline or amorphous. As it is capable of crystallising in forms belonging to two systems of crystallisation, it is said to be dimorphous. Sulphur in acute rhombic octahedrons (fig. 55), belonging to the right prismatic system (see *ante*, p. 145), is found native, and may be also obtained by crystallising sulphur from its solution in sulphuret of carbon. Sp. gr. 2·0454.

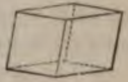
FIG. 55.



Acute rhombic octahedron (the principal form of native sulphur).

Sulphur in oblique rhombic prisms (fig. 56), belonging to the oblique prismatic system (see *ante*, p. 146), is obtained by fusing it and allowing it to cool slowly. Sp. gr. 1·982.

FIG. 56.



Oblique rhombic prism (principal form of sulphur by fusion and slow cooling).

When sulphur is heated to 340°, it becomes viscid; and, by increasing the heat, the viscidity increases, until the temperature arrives at between 400° and 500°. If, while in this state, it be suddenly cooled, as by throwing it into water, it remains quite soft, so that it may be drawn out into threads. In this state it is called *soft amorphous sulphur*. Its sp. gr. is from 1·957 to 1·961. If it be melted and cooled slowly, it reacquires its crystalline property.

[Sulphur, after having been heated to this high temperature and cooled, as above described, must be regarded as changed in its chemical nature. It is, in fact, sulphur in a new form, so that we must regard the element as capable of assuming the allotropic state. Its physical qualities are changed: thus it is of dark colour, and instead of being brittle is soft, like warmed glue or caoutchouc. Again, the vapours evolved from sulphur, when heated to the above high temperature, are endowed with far more energetic chemical combining qualities than are ordinary sulphur vapours.—ED.]

The sulphur of commerce occurs in three prevailing colours; namely, lemon yellow verging on green, dark yellow, and brown yellow: these shades result, partly at least, from the different degrees of heat to which it has been exposed during its fusion or extraction on the large scale, the palest variety having been the least heated (Brande).

Sulphur has a very feeble odour, and scarcely any taste. It is a bad conductor of electricity; and, therefore, by friction becomes powerfully electric. It is a bad conductor of heat; and when grasped in the warm hand, crackles, and sometimes breaks to pieces. It is fusible, volatilisable, and combustible. In atmospheric air it burns with a pale blue flame, and emits a large quantity of fumes having a peculiar suffocating odour (*sulphurous acid*).

Characteristics.—Sulphur is easily distinguished from other bodies by its fusibility, its volatility, and its burning with a blue flame, and the evolution of sulphurous acid gas, the odour of which can be easily recognised.—The presence of sulphur in some metallic sulphurets may be recognised by the evolution of sulphuretted hydrogen when they are treated with hydrochloric acid. In other sulphurets, the sulphur is detected by the odour of sulphurous acid which they evolve when heated on charcoal before the blow-pipe.—In some organic substances (*e. g.* fibrin, albumen, casein, cystic oxide, &c.) sulphur may be detected by boiling them in a solution of caustic potash to which acetate of lead has been added: sulphuret of lead (known by its dark or black appearance) is obtained.—In some cases the presence of sulphur is determined by fusing the suspected substance with caustic potash and nitrate of potash, and thereby converting the sulphur into sulphuric acid, which may be detected by the barytic salts (see *Sulphuric Acid*).

PURITY.—Sulphur, when pure, is perfectly volatile; the presence of fixed earthy impurities may, therefore, be detected by volatilising it.—Pure sulphur is soluble in boiling oil of turpentine, which does not act on the usual impurities of commercial sulphur.—If sulphur contain sulphuret of arsenic, digest in caustic ammonia, which has no action on pure sulphur, but dissolves the arsenical sulphuret; and on supersaturating the solution with hydrochloric acid, a yellow precipitate of arsenical sulphuret is obtained.

PHYSIOLOGICAL EFFECTS. α. *On Vegetables.*—Sulphur does not appear to be injurious to vegetables, for seeds vegetate and produce thriving plants when sown in sulphur.

β. *On Animals.*—At the veterinary school of Lyons it was found that a pound of sulphur killed horses by producing violent inflammation, recognisable during life by the symptoms, and after death by the morbid appearances.[1]

γ. *On Man.*—The general action of sulphur on the system has been already noticed (see *ante*, pp. 97 and 188). On account of its being almost insoluble in the animal juices, its topical action is scarcely more than that of a mechanical irritant. As I have before observed (see *ante*, p. 188), sulphur is probably rendered soluble, and therefore absorbable, by the soda of the bile.

In *small* and *repeated doses*, sulphur acts as a gentle stimulant to the secreting organs, especially to the skin and the mucous membranes, particularly the bronchial membrane. It promotes the capillary circulation of these parts, and increases their secretions. Sundelin[2] says it operates specifically on the mucous membrane of the rectum, and thereby promotes critical hemorrhoidal secretions. That it becomes absorbed is shown by the odour of hydrosulphuric acid which it communicates to the sweat, urine, and milk, and by silver articles becoming blackened in the pockets of patients who are under the influence of it. By the German physicians it is considered a resolvent. "From mercurial and antimonial medicines," says Sundelin, "sulphur is distinguished by its great diffusibility, in virtue of which it approximates to the exciting tonic agents; and also by its not possessing the liquefacient properties of these agents."

In *larger doses*, as from one to three or four drachms, sulphur acts as a mild purgative, without exciting the pulse or occasioning griping. As the stools are usually solid, Dr. Paris[3] concludes that the action of sulphur on the bowels is confined to the muscular coat. In very large doses, Hartwig has seen it cause gastro-enteritis (Oesterlen).

---

[1] Christison's *Treatise on Poisons*.

[2] *Heilmittellehre*, Bd. i. S. 196.

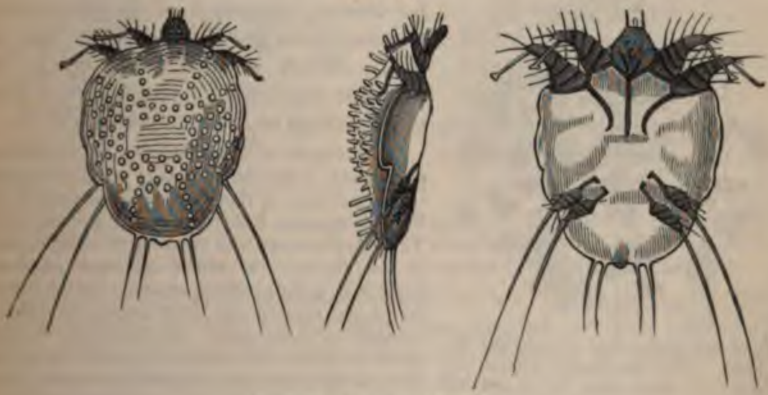
[3] *Pharmacologia*, vol. i. art. *Cathartics*.

USES.—Sulphur is employed both internally and externally.

a. Internally.—It is given for various purposes. *In affections of the rectum,* as stricture, hemorrhoids, and prolapsus, it is a valuable agent as a mild purgative: I have frequently employed it in these cases as a substitute for castor oil. In order to promote its purgative effect, it is sometimes necessary to conjoin magnesia or the bitartrate of potash. *In chronic cutaneous diseases,* more especially prurigo, impetigo, and scabies, the internal use of sulphur is sometimes attended with great benefit. *In pulmonary affections,* as chronic catarrhs and asthma, it is sometimes useful. *In rheumatic and gouty affections* also. After an attack of acute rheumatism, when the joints are left in a swollen and painful state, I have seen sulphur prove highly useful. It is popularly taken with ardent spirit (gin) in this complaint. It has been employed as an *anthelmintic.* Vogt employs it as a *resolvent* in inflammation; as in croup, bronchitis, peripneumonia, and abdominal inflammation. In some constitutional diseases, as scrofula and secondary syphilis, it has been used as an *alterative.* Tortual has proposed sulphur as a preservative against measles; but, as might be expected, experience shows sulphur possesses no prophylactic power of this kind, and that the only preservative is isolation.

β. Externally.—Sulphur is a most valuable remedy in various skin diseases, more especially *scabies.* It is supposed by some that its curative power in this disease depends on its poisonous influence over the so-called *itch-insect* (*Sarcoptes Hominis* of Raspail, the *Acarus Scabiei* of other writers), a little parasite belonging to the class *Arachnida* (spiders) of articulated animals, and therefore improperly termed an *insect.*[1]

FIG. 57.



Sarcoptes Hominis (Raspail).

But some doubts have been entertained whether this animal be the cause, effect, or mere accompaniment of itch. Rayer[2] observes, that it is indubitable that the number of these insects bears no proportion to that of the vesicles. "It is, further," he observes, "rare to discover these insects on the abdomen and on groins, where the eruption of scabies is nevertheless very common and very apparent; moreover, scabies is known to continue when no more acari are to be discovered." Sulphur is also a most valuable application in various other skin diseases, as porrigo, impetigo, &c.

---

[1] Raspail, *Mémoire sur l'Insecte de la Gale,* Paris, 1834.
[2] *Treatise on Diseases of the Skin,* by Dr. Willis, p. 344.

ADMINISTRATION.—See *Sulphur sublimatum* and *Sulphur præcipitatum*.

1. SULPHUR SUBLIMATUM; *Sublimed Sulphur; Flores Sulphuris*, or *Flowers of Sulphur*.—This substance is obtained by sublimation in the way already explained (see *ante*, p. 352).

The *Edinburgh College* orders it to be thus prepared:—

> "Sublime sulphur in a proper vessel; wash the powder thus obtained with boiling water in successive portions till the water ceases to have an acid taste; then dry the sulphur with a gentle heat."

As usually prepared, sublimed sulphur is apt to be contaminated with a little adhering acid (formed by the oxidation of sulphur), which, in the Edinburgh Pharmacopœia, is ordered to be removed by washing. When thus purified, it is called *washed sulphur* (*sulphur lotum* vel *depuratum*).

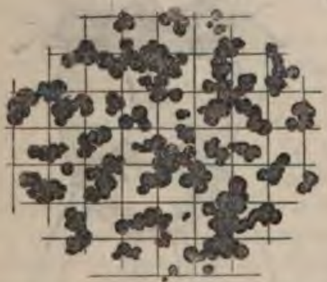
The *Dublin College* no longer retains the *sulphur lotum*. *Sulphur sublimatum* is mentioned, however, in the materia medica.

The purity of sublimed sulphur is thus directed to be ascertained by the *London College*:—

> Citron coloured. At a temperature of 600° it is sublimed. It is dissolved in oil of turpentine by the aid of heat.

Sublimed sulphur is a powder of a beautiful greenish-yellow colour. It is slightly gritty between the teeth. When examined by the microscope, it is found to consist of smooth, almost opaque, nodular masses, composed of globules[1] united together while in the liquid state (see fig. 58). When crushed, they break into irregular fragments. No crystals or traces of crystalline texture are perceptible.[2]

FIG. 58.



Microscopic appearance of sublimed sulphur. (The micrometer squares are equal to those seen in figures 59 and 60.)

If the vapour of boiling sulphur be received on a glass plate, it condenses in very small transparent viscid globules. If these be kept undisturbed, they become opaque, but retain their rounded form. This condition, as well as absence of light, exists in the chamber in which sublimed sulphur is deposited, and, therefore, accounts for the rounded forms and smoothness of the nodules of sublimed sulphur of commerce. If, however, the glass plate be shaken and exposed to light, the globules become converted into crystalline masses, whose surface is uneven from the projecting crystals.

---

[1] Six globules, including some of the largest and smallest, were carefully measured for me by my friend Mr. Jackson. Their diameters (in parts of an inch) were as follows:—

$0{\cdot}0012 = \frac{1}{833}$
$0{\cdot}0008 = \frac{1}{1250}$
$0{\cdot}0007 = \frac{1}{1432}$
$0{\cdot}00031 = \frac{1}{3210}$
$0{\cdot}00028 = \frac{1}{3560}$
$0{\cdot}00022 = \frac{1}{4546}$

[2] Fritzsche, *Pharm. Central-Blatt. für* 1838, p. 262; also Schweitzer, *Pharmaceutical Journal*, vol. ii. pp. 524–5, 1843.

Internally, sublimed sulphur is usually given with syrup or treacle, in the form of an electuary, or suspended in milk. The dose of it, as a purgative, is from one to three or four drachms. As an alterative or sudorific, the dose is about half a drachm.

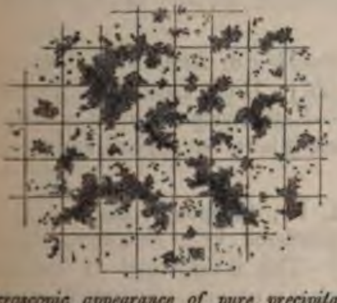
2. SULPHUR PRÆCIPITATUM; *Precipitated Sulphur; Lac Sulphuris,* or *Milk of Sulphur.*—This preparation was known to Geber.[1] It is prepared by boiling together sublimed sulphur, one part; slaked lime, two parts; and water, eight parts. To the filtered solution is to be added a sufficient quantity of hydrochloric acid to precipitate the whole of the sulphur, which is collected and dried in a stove.

According to L. Gmelin, when sulphur, excess of lime, and water, are boiled together, hyposulphite of lime is formed in solution along with a compound either of pentasulphuret of calcium and of lime, or of pentasulphuret of hydrogen and lime: $13CaO + 12S = 2(5CaO,CaS^5) + CaO,S^2O^2$; or $13CaO + 12S + 2HO = 2\,(6CaO,HS^5) + CaO,S^2O^2$. When hydrochloric acid is added to this solution, water, chloride of calcium, and sulphur, are formed: $2(5CaO,CaS^5) + CaO,S^2O^2O^2 + 13HCl = 13HO + 13CaCl + 12S$; or $2\,(6CaO,HS^5) + CaO,S^2O^2 + 13HCl = 13HO + 13CaCl + 12S + 2HO$.

Precipitated sulphur occurs in the form of a fine, soft, dull yellowish powder, with a greyish tint. It differs from sublimed sulphur in its fineness and softness, in its paler yellow colour, in its greyish tint, and its not being gritty between the teeth.

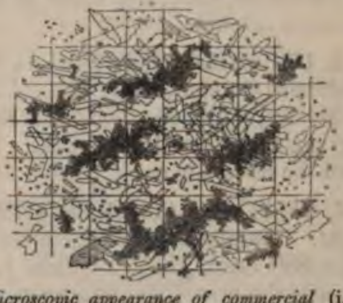
When submitted to microscopic examination, it is found to consist of very minute globules[2] or granules considerably smaller than the globules of sublimed sulphur (see fig. 59). No crystals or crystalline structure are perceptible.

FIG. 59.



Microscopic appearance of pure precipitated sulphur. (The micrometer squares are equal to those seen in figs. 58 and 60.)

FIG. 60.



Microscopic appearance of commercial (i. e. *impure*) *precipitated sulphur, showing the crystals of sulphate of lime* (*selenite*).

Precipitated sulphur is now placed by the London College among the articles of the materia medica, with the following note appended:—"Pale yellow. The water in which it is boiled does not redden litmus. It answers in other respects to the description above given of sulphur."

As found in commerce, precipitated sulphur usually contains water; and hence it has been called *hydrate of sulphur.* But both Bucholz and Bischoff have shown that when well dried it contains hardly a trace of water; and, therefore, that which, under ordinary circumstances, is contained in it, must be regarded as hygroscopic, so that the term *hydrate* is not applicable to it.

---

[1] *Invention of Verity,* chap. vi.

[2] Six of these globules were carefully measured for me by Mr. Jackson: their diameters (in parts of an inch) were as follows:—

$0{\cdot}00042 = \frac{1}{2380}$
$0{\cdot}0004 = \frac{1}{2500}$
$0{\cdot}00035 = \frac{1}{2850}$
$0{\cdot}00016 = \frac{1}{6250}$
$0{\cdot}00007 = \frac{1}{14300}$
$0{\cdot}00006 = \frac{1}{16600}$

Berzelius says that when melted it gives out a little sulphuretted hydrogen, and on cooling resumes the yellow colour it had before it was boiled with the alkali. H. Rose[1] ascribes the paleness of precipitated sulphur to the presence of sulphuretted hydrogen, or probably of persulphuret (pentasulphuret) of hydrogen, HS^5.

The precipitated sulphur of commerce is most extensively adulterated with sulphate of lime. In its preparation, sulphuric acid has been substituted for hydrochloric acid, by which the product contains nearly two-thirds of its weight of crystallised sulphate of lime. Mr. Schweitzer[2] analysed a sample, and found its composition to be as follows:—

Sulphate of lime	50·
Water of crystallisation of ditto	13·1
Sulphur	36·9
Lac Sulphuris of the shops	100·0

This adulterated variety is paler than the pure preparation; and by reflected artificial light it has a glistening or satiny appearance, owing to the presence of the crystals of sulphate of lime. When submitted to microscopic examination, it is found to consist of the granules or small globules of precipitated sulphur before mentioned, largely intermixed with crystals (see fig. 60). The adulteration is readily detected by subjecting the suspected preparation to heat in a crucible or on a fire shovel, when the sulphur and water of crystallisation are volatilised, leaving behind the anhydrous sulphate of lime. Or the sulphur may be dissolved out by oil of turpentine or liquor potassæ.

The effects, uses, and doses of this preparation are the same as those of sublimed sulphur.

3. UNGUENTUM SULPHURIS, L. E. D.; *Sulphur* or *Brimstone Ointment.* (Sublimed Sulphur, lb. ss. [℥j., *E.*; lb. j., *D.*]; Hog's Lard, lb.j. [℥iv., *E.*; lb. iv., *D.*] Mix them thoroughly together.)—Extensively employed in scabies, porrigo, and other skin diseases. In scabies, it is to be applied every night until the disease is cured.

4. UNGUENTUM SULPHURIS COMPOSITUM, L.; *Compound Sulphur Ointment.* (Sulphur, ℥iv.; White Hellebore, powdered, ʒx.; Nitrate of Potash, ℈ij.; Soft Soap, ℥iv.; Lard, lb. j. Mix.)—This is employed in the same cases as the preceding preparation, than which it is considered more efficacious, but at the same time more irritating.

5. OLEUM SULPHURATUM; *Sulphuretted Oil; Balsamum Sulphuris*, or *Balsam of Sulphur.*—In the London Pharmacopœia for 1824, this compound was ordered to be prepared by dissolving 1 part of Sublimed Sulphur in 8 parts of Olive Oil. The compound thus procured cannot be regarded as a mere solution of sulphur in oil, since the odour of hydrosulphuric acid which it possesses proves that the oil has undergone partial decomposition: in fact, the heat to which the oil is raised in order to boil it, causes a chemical change.[3]

It is a dark reddish-brown viscid substance, having an extremely unpleasant odour. Its local action is that of an acrid; its remote operation that of a stimulant, causing thirst and febrile heat. It has been supposed to possess expectorant and diaphoretic properties. It is applied to foul ulcers, and is employed internally in chronic pulmonary affections. The dose of it is from 40 to 50 drops; but its unpleasant taste and smell almost preclude its use.

---

[1] Poggendorff's *Annalen*, xlvii.; also *Pharm. Central-Blatt für* 1839, S. 441.

[2] *British Annals of Medicine*, vol. i. p. 618.

[3] A mixture of equal parts of tallow and sulphur, heated in a glass flask, yields pure sulphuretted hydrogen (Reinsch, quoted by L. Gmelin).

6. SULPHUR VIVUM;[1] *Horse Brimstone,* or *Sulphur Caballinum; Sulphur Griseum; Black Sulphur,* or *Sulphur nigrum.*—This is a grey powder composed of sulphur and various impurities. It is the dregs remaining in the subliming pot after the purification of sulphur. When examined by the microscope, it is found to differ both from sublimed sulphur and precipitated sulphur, and to consist of irregular broken particles. It has obviously been prepared by grinding. It is popularly supposed to be stronger than sublimed sulphur, and is in common use in various complaints as a substitute for the latter; but its employment is dangerous on account of the occasional presence of arsenic.

11. ACIDUM SULPHURICUM.—SULPHURIC ACID.

Formula SO^3. *Equivalent Weight* 40. *Equivalent Volume of Vapour* 1 or

HISTORY.—This acid appears to have been known to Geber as early as the seventh century.[2] In the state in which we usually meet with it in English commerce, it is usually denominated *oil of vitriol.* It was formerly called *vitriolic acid* (*acidum vitriolicum*).

NATURAL HISTORY.—It is found in both kingdoms of nature.

a. IN THE INORGANISED KINGDOM.—It is found in the waters of some volcanic regions, and is evidently produced by the combustion of sulphur. The *Rio Vinagre* (Vinegar River), which descends from the volcano of Puracé in Colombia to Popayan, has received its name from its acid properties, which it derives from being impregnated with sulphuric and hydrochloric acids.[3] Issuing from the crater of Mont Ida, in Java, is a river which also contains this acid. It also exists in the rain falling over large towns (*see ante,* p. 350).

Dr. Thomas Thomson[4] states that in Persia there is an earth so strongly impregnated with it, that it is used by the natives as an acidulous seasoner of food.

This author also says[5] that there are no less than twenty seven sulphates (consisting of combinations of sulphuric acid with one or more bases) in the mineral kingdom. The most abundant of these is the sulphate of lime. The *sour springs* of Byron, Genesse county, ten miles south of the Erie canal, contain pure sulphuric acid.[6]

FIG. 61.

Cascade of Vinagre in Colombia.

---

[1] The *sulphur vivum* or *quick sulphur* of Pliny (xxxv. 50) was dug out of the earth. Pliny says it was transparent and greenish.

[2] Thomson's *System of Inorganic Chemistry,* vol. ii. p. 29.

[3] A. de Humboldt, *Vues des Cordillères,* p. 220.

[4] *Mineralogy,* vol. i. p. 75.

[5] *Op. cit.* p. 77.

[6] Eaton, *Quarterly Journal of Science,* 1829, p. 200.

β. In the Organised Kingdom.—The sulphates of lime, potash, and soda, have been found in plants.[1] The sulphates of potash and soda are mentioned by Berzelius[2] as constituents of human urine.

Manufacture of Oil of Vitriol.—This subject I shall consider under three heads:—1st, the substances employed; 2dly, the apparatus or plant used; and 3rdly, the process.

1st. *Substances employed.*—These are eight in number, viz.:—

1st. Sulphur, S; or 2dly, Iron pyrites, FeS^2.
3d. Nitrate of potash, KO,NO^5; or 4thly, Nitrate of soda, NaO,NO^5.
5th. Sulphuric acid of sp. gr. 1·750: HO,SO^3 plus water.
6th. Atmospheric air, consisting of about N^2 and O.
7th. Steam.
8th. Water.

The sulphur employed is that imported from Sicily. To check its combustion, it is sometimes mixed with earthy matter, and made into truncated pyramidal masses, which are burnt in the usual way. For cheapness, pyrites is frequently substituted; but as it is frequently intermixed with arsenical pyrites, the oil of vitriol obtained by it is apt to be contaminated with arsenious acid. The pyrites used for the purpose is procured from the Isle of Sheppey, and various parts of the south and south-eastern coast of England, from Wicklow in Ireland, from the Cornish mines, and even from St. Lucia. The first, on account of its almost entire freedom from arsenic, is the best. The Cornish pyrites is highly arsenical.

The alkaline nitrate is employed to yield nitric acid. The manufacturer's preference of the one nitrate for the other is founded on motives of economy. For every cwt. of sulphur burnt, about 10 lbs. of nitre will be sufficient.

2. *Apparatus* or *plant.*—This consists of six parts, viz.:—

1. The sulphur- or pyrites-burner.
2. The nitrate pot.
3. One or more leaden chambers or houses.
4. Leaden concentration pans.
5. Glass or platinum retort.

The sulphur-burner (fig. 62, *b*; and fig. 63, *a*) is a kind of furnace, for the grate of which a stone hearth or iron plate, called the sole, is substituted, on which the sulphur is burnt. The construction of the pyrites-burner is somewhat different, and varies for different kinds of pyrites. It requires to have a fire-grate for the more abundant supply of air. The flue (fig. 63, *f*) of the sulphur or pyrites opens into the leaden chamber.

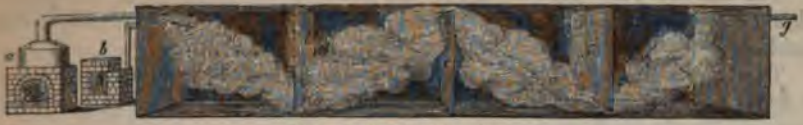
The nitrate-pot or pan is of cast iron. In it the nitrate is decomposed by the sulphuric acid. It is placed in the burner when required.

The leaden chamber has the form of a parallelopiped. Its size varies according to the work it is required to do. To produce ten tons of oil of vitriol weekly, the chamber should have a capacity of 35,000 cubic feet; or a length of 187 feet, a breadth of 12½ feet, and a height of 15 feet.[3] The bottom of it is covered to the extent of three or four inches with water acidulated with sulphuric acid. Sometimes there is a leaden antechamber to receive and mix the gases before their entrance into the larger chamber. Sometimes the leaden chamber is divided into two or three compartments by leaden curtains placed across it, as shown in the following cut taken from Professor Graham's *Elements of Chemistry*, vol. i. p. 324.

---

[1] De Candolle, *Phys. Végét.* p. 390.
[2] *Traité de Chim.* t. vii. p. 393.
[3] *Pharmaceutical Times*, Jan. 2, 1847.

FIG. 62.



Oil of Vitriol Chamber.

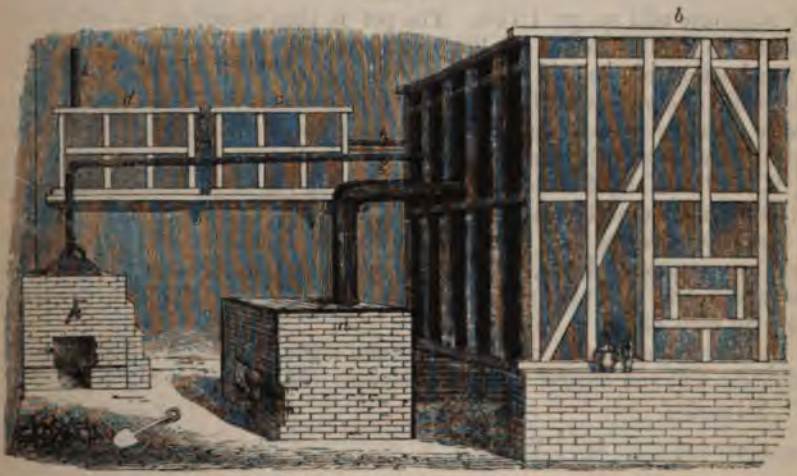
- *a*. Steam boiler.
- *b*. Section of furnace or burner.
- *d* and *f*. Leaden curtains suspended from roof of the chamber to within six inches of the floor.
- *e*. Leaden curtains rising from the floor to within six inches of the roof.
- *g*. Leaden conduit or vent-tube for the discharge of uncondensible gases. It should communicate with a tall chimney to carry off these gases, and to occasion a slight draught through the chamber.

These curtains "serve to detain the vapours, and cause them to advance in a gradual manner through the chamber, so that the sulphuric acid is deposited as completely as possible before the vapours reach the discharge tube."

Sometimes small chambers (see fig. 63. *c*, *d*), also containing water, or long tunnels, are appended to the larger chamber, from which they receive the escaping gases before they are allowed to pass out into the air. These chambers are intended to prevent loss in the process.

In one manufactory which I inspected, the chambers communicated with each other through a double-necked stone bottle, at the bottom of which was water.

FIG. 63.



Oil of Vitriol Manufactory.

- *a*. Sulphur-burner or furnace.
- *b*. First leaden chamber.—In the manufactory from which the above sketch was made, this chamber was 70 feet long, 20 feet wide, and 20 feet high; but the size varies considerably in different establishments.
- *c*. Second } smaller leaden chambers.
- *d*. Third } smaller leaden chambers.
- *e*. Steam boiler.
- *f*. Flue-pipe or chimney of the furnace.
- *g*. Steam pipe.
- *h*. The flue or pipe conveying the residual gas from the first to the second leaden chamber.
- *i*. Pipe conveying the gas not absorbed in the first and second chambers into the third.
- *k*. The flue or waste pipe.
- *l*. Man-hole, by which the workmen enter the chamber when the process is not going on.
- *m*. Pipe for withdrawing a small portion of sulphuric acid from the chamber, in order to ascertain its sp. gr. by the hydrometer.

The flue- or waste-pipe of the leaden chamber serves to carry off the residual nitrogen of the air; but a portion of the binoxide as well as sulphurous acid also escape by it.

The concentration pans are rectangular leaden pans set in brickwork over a fire; plates of iron, or tiles, and sometimes a bed of sand, being interposed between the fire and the pan.

The glass or platinum retort is also for the purpose of concentration. Platinum retorts, notwithstanding their great cost, are now usually adopted. Their price of course depends on their size. Mr. Parkes[1] had one which held thirty gallons, and cost about £360; but sometimes they are made so large that they are worth £1000 each. The platinum is protected from the direct action of the fire by being set in an iron pot.

3. *The process.*—The process of the manufacture of oil of vitriol consists of four parts or stages—

1. The oxidation of sulphur and its conversion into sulphurous acid.
2. The oxidation of the sulphurous acid and its conversion into sulphuric acid.
3. The concentration of the dilute sulphuric acid in leaden pans.
4. The final concentration in platinum retorts.

By combustion in the burner, the sulphur combines with atmospheric oxygen, and is converted into sulphurous acid gas: $S+O^2=SO^2$. This passes by the flue-pipe into the leaden chamber. The entrance of air into the burner is regulated by a sliding door.

The nitrate is placed in the nitrate pot, and mixed with the proper quantity of sulphuric acid sp. gr. 1·750. The pot is then placed on the sole of the burner, so that the flames of the burning sulphur play beneath it. By the mutual action of the acid and the nitrate, an alkaline sulphate is obtained, and nitric acid vapour evolved. This is conveyed by the flue-pipe into the leaden chamber. Assuming nitrate of soda to be employed, the following equation represents the changes which occur in the nitrate pot: $NaO,NO^5+2(HO,SO^3)=NaO,2SO^3+2HO,NO^5$. Part of the nitric acid vapour passes into the leaden chamber in the form of nitrous acid and oxygen.

Steam is conveyed into the leaden chamber from a boiler. It serves at least two purposes: firstly, it causes the intermixture of the sulphurous acid gas and nitric acid vapour; and secondly, it enables these two agents to react on each other.

By the mutual reaction of sulphurous and nitric acid gases, aided by steam, sulphuric acid and nitrous acid are produced. $SO^2+NO^5=SO^3+NO^4$.

MATERIALS.				PRODUCTS.	
1 eq. Nitric Acid	54	*1 eq. Nitrous Acid*	46	1 eq. Nitrous Acid	46
		1 eq. Oxygen	8		
1 eq. Sulphurous Acid .	32			1 eq. Sulphuric Acid ...	40
	86				86

According to Peligot,[2] the nitrous acid produced by the above reaction is converted by water into nitric and hyponitrous acids. $2NO^4+HO=HO,NO^5+NO^3$. The hyponitrous acid under the influence of more water becomes converted into nitric acid and binoxide of nitrogen. $3NO^3+HO=HO,NO^5+2NO^2$. The binoxide of nitrogen in contact with air absorbs oxygen and is converted into nitrous acid. $NO^2+O^2=NO^4$; and this, by the aid of water, is converted into hyponitrous and nitric acids, as before.—Thus, according to Peligot, the sulphurous acid acts *incessantly and exclusively* on the nitric acid.

---

[1] *Chem. Essays*, vol. i. p. 535.

[2] *Ann. Chim. et Phys.* 3me sér. xii. 1844.

If there be an insufficient supply of steam, a crystalline substance,[1] the bisulphate of the binoxide of nitrogen, is formed, $NO^2,2SO^3$. When this comes in contact with water it is decomposed, hydrated sulphuric acid is formed, and binoxide of nitrogen gas escapes, causing effervescence: $NO^2, 2SO^3+2HO=NO^2+2(HO,SO^3)$.

This crystalline substance may readily be formed by conveying sulphurous acid gas into a tall jar, at the bottom of which a small quantity of colourless but concentrated nitric acid is contained. Brown vapours of nitrous acid are evolved, sulphuric acid is formed, and the jar becomes lined with the crystalline matter, which dissolves with effervescence in water.

Attempts have been made to manufacture oil of vitriol without the employment of nitric acid. Mr. Peregrine Phillips has proposed to convert sulphurous acid into sulphuric acid at the expense of the oxygen of the air, by mixing sulphurous acid with an excess of air by a blowing apparatus, and carrying it through a tube filled with platinum sponge, or balls of fine platinum wire (*Graham*). More recently, Schneider[2] has proposed to substitute pumice for spongy platinum; and he states that, by means of it, oil of vitriol of sp. gr. 1·845 can be made without the use either of leaden chambers or platinum retorts.

[In 1849 Dr. Pereira made the following note:—"Inspected Tennant's manufactory for oil of vitriol: they employ Gay-Lussac's process for passing the nitrous fumes into oil of vitriol; by this they reduce the quantity of nitre to 2 per cent."—ED.]

When the liquid in the leaden chamber has acquired a sp. gr. of about 1·5 (1·6 or 1·7, according to Mr. Farmer's statement to me), it is conveyed by leaden pipes into rectangular leaden boilers, where it is evaporated and concentrated until its sp. gr. is 1·70 (1·75, Farmer); but in some manufactories this part of the process is omitted.

The final concentration is effected in the platinum retort. Here the acid is deprived of a further portion of its water, and acquires a sp. gr. of 1·845; it is drawn off by means of a platinum syphon into carboys. In this part of the process the acid is deprived of some sulphurous acid as well as water.

Old method.—The old method of manufacturing oil of vitriol, and, indeed, one still followed in some places, consists in burning a mixture of eight parts of sulphur and one part of nitrate of potash (or nitrate of soda) on iron or leaden pipes, either within the leaden chamber or in a furnace on the outside of it.[3] Fig. 64 is the ground plan of a manufactory of this kind.

In this process an equivalent of sulphur combines with two equivalents of atmospheric oxygen to form one equivalent of sulphurous acid. Another equivalent of sulphur abstracts three equivalents of oxygen from one equivalent of nitric acid of the nitrate, and thereby becomes sulphuric acid, which, with the potash of the nitre, forms an equivalent of sulphate of potash.

---

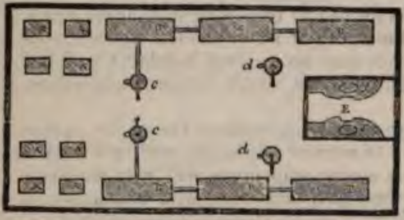
[1] Much difference of opinion has existed with respect to the nature of the crystalline matter which is occasionally formed in the leaden chamber of the sulphuric acid manufacturer. Davy (*Elements of Chemical Philosophy*, p. 276, 1812) regarded it as a compound of *water*, *nitrous acid*, and *sulphurous acid*. Dr. W. Henry (*Annals of Philosophy*, new ser. xi. p. 368), and afterwards Gaultier de Claubry (*Ann. de Chim. et Phys.* t. xlv. p. 284), submitted it to analysis. The latter found its constituents to be *anhydrous sulphuric acid* 65·59, *hyponitrous acid* 23·96, and *water* 10·10. In 1839, Heinrich Rose (*Pharm. Central-Blatt für* 1839, S. 664) described a solid compound of *anhydrous sulphuric acid* and *binoxide of nitrogen*: $2SO^3+NO^2$. Adolphe Rose (*Ibid. für* 1840, S. 481; also *Journ. de Pharm.* t. xxvii. p. 138) has shown that the crystals which form in the leaden chamber consist of *sulphuric acid*, *binoxide of nitrogen*, and *water*. M. Provostaye (*Journ. de Pharm.* t. xxvi. p. 637) has also examined this crystalline matter.

[2] *Pharmaceutical Journal*, vol. vii. p. 547, 1848.

[3] Parkes's *Chemical Essays*, vol. i. 465.

One equivalent of binoxide of nitrogen is evolved by the decomposed nitric acid, and this, combining with two equivalents of atmospheric oxygen, becomes nitrous acid, which, aided by the presence of water, is converted into nitric and hyponitrous acids, as before explained. The nitric acid oxidises the sulphurous acid, and converts it into sulphuric acid.

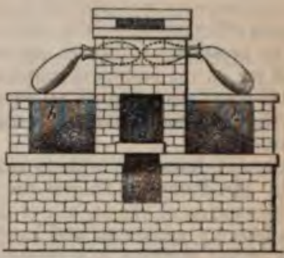
FIG. 64.



Plan of an Oil of Vitriol Manufactory.

A. Rectangular leaden boiler.
B. Leaden chambers.
E. Retort house.
c. Leaden pump for acid.
d. Water pump.

FIG. 65.



Furnace Gallery for the Distillation of Fuming Sulphuric Acid.

a. The fire-place.
b, b. Chamber on each side of the fire-place for depriving the copperas (*c c*) of its water.

MANUFACTURE OF FUMING, SAXONY, OR NORDHÄUSEN SULPHURIC ACID.—At Goslar, Nordhäusen, and other parts of Saxony, sulphuric acid is made thus:—Common sulphate of iron (*copperas* or *green vitriol*) is deprived of its water of crystallisation by heat, and then distilled in earthenware, tubular, or pear-shaped retorts contained in a gallery furnace (fig. 65). Some oil of vitriol is put into the earthenware receivers, to condense the dry sulphuric acid which comes over. Sesquioxide of iron (*colcothar* vel *caput mortuum vitrioli*) is left in the retort.

PRODUCTION OF ANHYDROUS SULPHURIC ACID.—By distilling the fuming or Nordhäusen sulphuric acid from a glass retort into a dry and cold receiver, the vapour of the anhydrous acid passes over and concretes in the receiver. $HO,2SO^3 = SO^3 + HO,SO^3$.

PROPERTIES. α. **Of Anhydrous Sulphuric Acid,** SO^3.—It is a white crystalline solid, having very much the appearance of asbestos. Exposed to the air it attracts water, and flies off in the form of dense white fumes. It melts at 66° F., and boils at from 104° to 122° F. (125° to 132°·8, Fischer). The sp. gr. of the liquid acid at 78° F. is 1·97. The sp. gr. of its vapour is, according to Mitscherlich, 3·0, but this is probably too high. It does not redden litmus unless moisture be present. Its composition is as follows:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Berzelius.*
Sulphur	1	16	40	40·14
Oxygen	3	24	60	59·86
AnhydrousSulphuricAcid	1	40	100	100·00

	Vol.	*Sp. Gr.*
Sulphurous acid gas	1	2·2112
Oxygen gas	0·5	0·5528
Sulphuric Acid Vapour	1	2·7640

β. **Of Nordhäusen or Fuming Sulphuric Acid,** $HO,2SO^3$.—This is usually a dark brown (from some organic matter) oily liquid, which gives out copious white fumes in the air. Its sp. gr. is about 1·9. It is imported in stone bottles, having a stoneware screw for a stopper. When subjected to heat, it gives out the vapour of anhydrous sulphuric acid: the residue in the retort resembles oil of vitriol. The composition of fuming sulphuric acid is as follows:—

	Atoms.	*Eq. Wt.*	*Per Cent.*			*At.*	*Eq.Wt.*
Anhydrous sulphuric acid	2	80	89·88	or	Anhydrous sulphuric acid	1	40
Water	1	9	10·11		Protohydrate sulphuric acid	1	49
Fuming Sulphuric Acid	1	89	99·99			1	89

L. Gmelin says that it is to be regarded as a compound of one atom of water with several atoms of dry sulphuric acid, or of common oil of vitriol with dry acid.

It is often contaminated with sulphurous acid, selenium, earths, oxide of iron, and organic matter. When obtained by putting oil of vitriol into the receiver, as above mentioned, it is of course contaminated with all the impurities contained in the latter.

γ. **Oil of Vitriol, or English Sulphuric Acid.**—This is a colourless, transparent, inodorous, highly acrid, and corrosive liquid. It possesses the usual properties of a powerful mineral acid in a very eminent degree, such as reddening the vegetable blues, saturating bases, and displacing other acids. Its affinity for water is most intense; and by virtue of this it absorbs aqueous vapour from the atmosphere, and chars animal and vegetable substances. When mixed with water there is a mutual condensation, with the evolution of heat. Various substances, when heated in sulphuric acid, decompose it: they abstract oxygen and evolve sulphurous acid. This is the case with charcoal, organic substances, phosphorus, sulphur, and several of the metals, as copper, tin, and mercury.

Exclusive of the fuming or Nordhäusen sulphuric acid, there are, according to Graham, three hydrates of sulphuric acid, containing respectively one, two, and three atoms of water to one of dry acid.

1. *Monohydrate of sulphuric acid; oil of vitriol, sp. gr.* 1·845; *Acidum sulphuricum,* L. E. D.; HO,SO^3.—Dense and colourless, and of an oily consistence. Boils at 620°, and freezes at −29°F., yielding often regular six-sided prisms of a tabular form.

	Atoms.	*Eq. Wt.*	*Per Cent.*
Real sulphuric acid	1	40	81·6
Water	1	9	18·4
Monohydrate of sulphuric acid	1	49	100·0

The London College fixes the sp. gr. of the officinal pure sulphuric acid at 1·843; the Edinburgh and Dublin Colleges, at 1·845 and 1·846 respectively.

2. *Binhydrate of sulphuric acid; congelable vitriolic acid; acid of sp. gr.* 1·78 (Graham); sometimes called *Eisöl* (*ice oil*); $2HO, SO^3$.—Mr. Graham regards one of the atoms of water as basic; that is, combined as a base with the acid, the other as combined with this sulphate of water. He therefore arranges the symbols as follows: HO, SO^3+HO.

In cold weather, acid of this density readily freezes, and produces large, regular, hard crystals, whose form resembles that of carbonate of soda and selenite. Their freezing and melting point is about 45° F.; that is, 13° above the freezing point of water. If the density be either augmented or lessened, the freezing point is lowered.[1] Their sp. gr. is greater than 1·924. In the solid state this acid has been called *frozen sulphuric acid.* Its composition is as follows:—

---

[1] Keir, *Phil. Trans.* vol. lxxvii. 1787.

	Atoms.	*Eq. Wt.*	*Per Cent.*
Real sulphuric acid	1	40	68·97
Water	2	18	31·03
Binhydrate of sulphuric acid	1	58	100·00

3. *Terhydrate of sulphuric acid; acid of sp. gr.* 1·632 (Graham); $3HO, SO^3$.—Mr. Graham regards one of the three atoms of water as basic, and therefore gives the following formula of the acid: HO,SO^3+2HO. This acid is obtained by evaporating a more dilute acid in vacuo at 212°. It is in the proportions of this hydrate that sulphuric acid and water undergo the greatest condensation, or reduction of volume, in combining.

	Atoms.	*Eq. Wt.*	*Per Cent.*
Real sulphuric acid	1	40	59·7
Water	3	27	40·3
Terhydrate of sulphuric acid	1	67	100·0

The following table, constructed by Dr. Ure.[1] shows the quantitty of dry or real acid, and of oil of vitriol, in 100 parts of liquid acid.

Specific Gravity	Per centage		Specific Gravity	Per centage		Specific Gravity	Per centage	
	of Dry Acid.	of Oil of Vitriol.		of Dry Acid.	of Oil of Vitriol.		of Dry Acid.	of Oil of Vitriol.
1.8485	81.54	100	1.5648	54.63	67	1.2490	27.72	34
1.8475	80.72	99	1.5503	53.82	66	1.2409	26.91	33
1.8460	79.90	98	1.5390	53.00	65	1.2334	26.09	32
1.8439	79.09	97	1.5280	52.18	64	1.2260	25.28	31
1.8410	78.28	96	1.5170	51.37	63	1.2184	24.46	30
1.8376	77.46	95	1.5066	50.55	62	1.2108	23.65	29
1.8336	76.65	94	1.4960	49.74	61	1.2032	22.83	28
1.8290	75.83	93	1.4860	48.92	60	1.1956	22.01	27
1.8233	75.02	92	1.4760	48.11	59	1.1876	21.20	26
1.8179	74.20	91	1.4660	47.29	58	1.1792	20.38	25
1.8115	73.39	90	1.4560	46.48	57	1.1706	19.57	24
1.8043	72.57	89	1.4460	45.66	56	1.1626	18.75	23
1.7962	71.75	88	1.4360	44.85	55	1.1549	17.94	22
1.7870	70.94	87	1.4265	44.03	54	1.1480	17.12	21
1.7774	70.12	86	1.4170	43.22	53	1.1410	16.31	20
1.7673	69.31	85	1.4073	42.40	52	1.1330	15.49	19
1.7570	68.49	84	1.3977	41.58	51	1.1246	14.68	18
1.7465	67.68	83	1.3884	40.77	50	1.1165	13.86	17
1.7360	66.86	82	1.3788	39.95	49	1.1090	13.05	16
1.7245	66.05	81	1.3697	39.14	48	1.1019	12.23	15
1.7120	65.23	80	1.3612	38.32	47	1.0953	11.41	14
1.6993	64.42	79	1.3530	37.51	46	1.0887	10.60	13
1.6870	63.60	78	1.3440	36.69	45	1.0809	9.78	12
1.6750	62.78	77	1.3345	35.88	44	1.0743	8.97	11
1.6630	61.97	76	1.3255	35.06	43	1.0682	8.15	10
1.6520	61.15	75	1.3165	34.25	42	1.0614	7.34	9
1.6415	60.34	74	1.3080	33.43	41	1.0544	6.52	8
1.6321	59.52	73	1.2999	32.61	40	1.0477	5.71	7
1.6204	58.71	72	1.2913	31.80	39	1.0405	4.89	6
1.6090	57.89	71	1.2826	30.98	38	1.0336	4.08	5
1.5975	57.08	70	1.2740	30.17	37	1.0268	3.26	4
1.5868	56.26	69	1.2654	29.35	36	1.0206	2.446	3
1.5760	55.45	68	1.2572	28.54	35	1.0140	1.63	2
						1.0074	0.8154	1

---

[1] *Journal of Science and Arts*, vol. iv. p. 122, 1818.

Commercial oil of vitriol (*Acidum sulphuricum venale*).—The oil of vitriol of commerce is seldom so strong as that directed to be kept by the London College: moreover, it is not absolutely pure, being always contaminated with lead, and sometimes with other substances. Mr. Phillips states that its sp. gr. is generally about 1·8433, and then it is constituted very nearly of

	Atoms.	*Eq. Wt.*	*Per Cent.*
Real sulphuric acid	1	40	78
Water	1¼	11·25	22
Oil of Vitriol, sp. gr. 1·8433	1	51·25	100

The sp. gr. of the *commercial* sulphuric acid of the Edinburgh Pharmacopœia is fixed at 1·840.

Characteristics.—Free sulphuric acid, as well as solutions of the soluble sulphates, yield, with a solution of the chloride of barium, or of nitrate of baryta, a heavy white precipitate (*sulphate of baryta*), insoluble in water and in nitric or hydrochloric acid. If this precipitate be ignited with charcoal, it is decomposed, and converted into sulphuret of barium; which, on the addition of hydrochloric acid, evolves sulphuretted hydrogen, known by its odour, and its blackening paper moistened with solution of acetate of lead.

A solution of a *sulphovinate* or *double sulphate of the oxide of ethule and a base*, does not yield a precipitate on the addition of a soluble barytic salt; but if the solution be boiled with nitric or hydrochloric acid, the sulphuric acid is set free, and may then be detected by a barytic salt.

Sulphate of baryta is slightly soluble in oil of vitriol; but water precipitates it from its solution.

Selenic acid yields with the barytic salts a white precipitate (*seleniate of baryta*), which is insoluble in nitric acid, but is soluble in boiling hydrochloric acid, with the disengagement of chlorine and the conversion of the seleniate into a selenite. The seleniate, when ignited with charcoal, does not yield sulphuretted hydrogen on the addition of hydrochloric acid.

Hydrofluosilicic acid yields with the barytic salts a white precipitate, almost insoluble in nitric and hydrochloric acids; but when heated with charcoal, and treated with hydrochloric acid, the precipitate does not evolve sulphuretted hydrogen.

A solution of chloride of barium or of nitrate of baryta, added to concentrated nitric or hydrochloric acid, gives rise to a precipitate (the solid chloride or nitrate), which is soluble in water.

Sulphuric acid and the soluble sulphates produce, with a solution of acetate of lead, a white precipitate (*sulphate of lead*), insoluble in dilute nitric acid, but soluble in hot concentrated hydrochloric acid.

Free sulphuric acid may be distinguished from a sulphate by sugar. Coat a piece of porcelain with a solution of sugar; then add the sulphuric acid, and heat by steam to dryness: the acid chars the sugar and produces a brown or black spot.

If sulphuric acid be heated with organic matter, sulphurous acid is given out. This may be known by its odour, and by its occasioning the formation of the blue iodide of starch when mixed with iodic acid and starch. Oil of vitriol reddens veratria, salicin, piperin, oil of bitter almonds, phloridzine, &c.

PURITY.—Commercial oil of vitriol is seldom quite pure. It may contain excess of *water*, by which its sp. gr. is lowered. It then more readily freezes in cold weather. It may contain *hydrochloric acid*, from the use of impure nitrate. Frequently an *oxide of nitrogen* (binoxide, or hyponitrous or nitric acid) is present. *Oxide of lead* combined with sulphuric acid, or sulphate of lead, is usually present. It is derived from the leaden walls of the chambers. *Arsenious acid* is not unfrequently present when the oil of vitriol has been obtained by the combustion of pyrites. *Organic matters* (from cork, straw, &c.) are often present.

The preceding are by no means infrequent impurities. But, in addition, the presence of several others has been signalised; as *selenium, lime, magnesia, titanium,* and the oxides of *zinc, tin, iron, copper,* and *mercury*. Some of them have been found, not in solution, but as a deposit (L. Gmelin).

Commercial acid, when genuine, should never have a sp. gr. greater than 1·8455; when it is denser, we may infer sophistication or negligence in the manufacture (Brande).

According to the *London College,* good oil of vitriol possesses the following characters:—

> Free of colour and odour. Specific gravity 1·843. Mixed with an equal bulk of water, it usually deposits a small quantity of a white matter. It emits no vapour of nitrous acid. Diluted with twelve parts of water, it throws down nothing of a yellow colour on the addition of hydrosulphuric acid. 100 grains of this acid are saturated by 285 grains of the crystals of carbonate of soda.

The *Edinburgh College* gives the following characters of it:—

> "Density 1840, or near it; colourless; when diluted with its own volume of water, only a scanty muddiness arises, and no orange fumes escape."

Oil of vitriol, when pure, is colourless; when it contains organic matter, it is more or less coloured, brownish or black.

Sulphate of lead may be detected by diluting the acid with either water or rectified spirit: in either case the sulphate is separated. The "muddiness" referred to by the Edinburgh College is due to this; as well as the milkiness which the addition of spirit to the acid occasions. If sulphuretted hydrogen be transmitted through the diluted acid, it usually occasions a very slight discolouration only (*sulphuret of lead*).

A solution of the protosulphate of iron detects the binoxide of nitrogen, nitrous acid, or nitric acid, by the reddish-brown or brownish-black colour which it gives rise to, "if a sufficient quantity of pure sulphuric acid be added to the liquid to be examined" (A. Rose). The solution should be poured over the suspected acid contained in a tube. A reddish, or brownish, or greenish-brown colour is produced at the time of contact of the two liquids. Binoxide of nitrogen gives a greenish-brown tinge to a solution of the protosulphate of iron. If either nitrous or nitric acid be present, a portion of protoxide is converted into sesquioxide of iron, with the evolution of binoxide of nitrogen, which is absorbed by some of the unaltered protosulphate of iron, to which it communicates a brownish tinge. Permanganate of potash is an excellent test for binoxide of nitrogen or nitrous acid in sulphuric acid diluted with about six parts of water. If either of these substances be present, the permanganate is decolourised. This effect is not produced by the presence of pure nitric acid in diluted sulphuric acid. Hence it distinguishes binoxide of nitrogen and nitrous acid from nitric acid.

Oil of vitriol which has been manufactured from iron pyrites is frequently contaminated with arsenic, mostly as arsenious acid; but sometimes in part also as arsenic acid.[1] Dr. Owen Rees[2] found 22·58 grains of arsenious acid in twenty fluidounces of oil of vitriol; and Mr. Watson[3] states that the smallest quantity which he has detected is 35½ grs. in twenty fluidounces. I have seen on the sides of the bottle containing arsenical sulphuric acid a deposit of crystallised arsenious acid. If zinc be added to the arsenical sulphuric acid diluted with four or five times its volume of water, hydrogen, mixed with arseniuretted hydrogen, is evolved (see *Arsenious Acid*).

Sulphuretted hydrogen transmitted through the diluted arsenical sulphuric acid, converts the arsenious acid, AsO^3, into orpiment, AsS^3, which falls as a yellow precipitate. Very minute quantities of arsenic may be detected by diluting the sulphuric acid with water, supersaturating with carbonate of potash, filtering to separate the deposited sulphate of potash, and washing with a little water, evaporating, supersaturating with hydrochloric acid, and transmitting sulphuretted hydrogen through the liquid (L. Gmelin[4]). If the arsenical sulphuric acid be diluted with water, and accurately saturated with ammonia, it yields with nitrate of silver a yellow precipitate if arsenious acid only be present, but a reddish precipitate if there be also arsenic acid (Wackenroder).

RECTIFICATION.—In order to free the oil of vitriol of commerce from its fixed impurities, it must be subjected to distillation. The acid obtained by this process is called *rectified, distilled, depurated*, or *purified oil of vitriol*. To prepare the *acidum sulphuricum purum*, E. D., the *Edinburgh College* states that—

> "If commercial sulphuric acid contain nitrous acid, heat eight fluidounces of it with between ten and fifteen grains of sugar, at a temperature not quite sufficient to boil the acid, till the dark colour at first produced shall have nearly or altogether disappeared. This process removes nitrous acid. Other impurities may be removed by distillation; which, on the small scale, is easily managed by boiling the acid with a few platinum chips in a glass retort, by means of a sand-bath or gas-flame, rejecting the first half-ounce."

The *Dublin College* orders—

> "Of Oil of Vitriol of commerce, any convenient quantity. Introduce it into a small plain retort containing a few slips of platinum foil, and passing the neck of the retort into a Florence flask which is to be used as a receiver, with the aid of a small charcoal fire or gas lamp distil over one-tenth of the acid. This being rejected, and a fresh receiver of the same kind being connected with the retort, let the distillation be resumed, and continued until no more than about an ounce of liquid remains behind. The distilled product should now be transferred to and preserved in a well-stopped bottle. The specific gravity of this acid is 1·846.

Mere distillation will not produce an absolutely pure sulphuric acid, since the volatile impurities, as nitrous acid, will also pass over. The sugar employed to destroy the latter (nitrous acid) also decomposes a portion of sulphuric acid, and evolves sulphurous acid, which is not entirely removed by the subsequent part of the process.

PHYSIOLOGICAL EFFECTS. α. *On Vegetables.*—In the concentrated state sulphuric acid chars the parts of plants to which it is applied. In the dilute form it destroys vegetables in a few hours.[5]

---

[1] Wackenroder, *Buchner's Repert.* Bd. xlvii. p. 337, 1834.

[2] *London Medical Gazette* for Feb. 5, 1841.

[3] *Ibid.* for Feb. 1841. Mr. Watson states that a man had nearly lost his life in consequence of the inhalation of arseniuretted hydrogen, produced in the manufacture of hydrochloric acid by the diluted unpurified pyrites, sulphuric acid acting upon the iron retort employed.

[4] *Handbook of Chemistry* (Cavendish Society's Works), vol. ii. p. 183.

[5] Marcet, in De Candolle's *Phys. Végét.* p. 1345.

β. On Animals generally.—The action of sulphuric acid on animals generally, is precisely the same as that on man. Thrown into the veins of a dog, Orfila found that it coagulated the blood, and caused immediate death.[1]

γ. On Man.—Diluted sulphuric acid is a thirst-quenching, refrigerant spanæmic (see *ante*, pp. 174 and 202). It sharpens the appetite, checks profuse sweating, and not unfrequently reduces the frequency and volume of the pulse. Under its use, the milk of nurses frequently acquires a griping quality. The effects of the acids on the urine have been already fully discussed (see *ante*, p. 177).

After the use of the acid for a few days, especially if it be exhibited in full doses, patients frequently complain of abdominal pain and griping. If its use be persevered in, these effects augment, heat and pain in the throat and stomach are experienced, the digestive functions are disturbed, and sometimes purging with febrile symptoms occurs.

The chemical changes presented by the acids in the alimentary canal have been already noticed (see *ante*, p. 175).

The concentrated sulphuric acid is a powerful corrosive or escharotic (see *ante*, p. 161). It abstracts and unites with water and bases contained in the tissues and secretions, coagulates albuminous liquors, combines with albumen, fibrine, and mucus, and darkens the colouring matter of the blood. If its action be carried further, it dissolves and decomposes the organic constituents of the tissues, charring or carbonising them.

The parts to which the acid is applied become, in the first place, white by the formation of sulphate of albumen. This effect is seen both in the cuticle and the cornea. By the more prolonged action of the poison, they assume a brownish or blackish appearance. Black spots are frequently observed in the stomachs of those who have swallowed the acid; and in the surrounding parts the blood is usually coagulated in the blood-vessels. Such are the topical chemical effects of this acid. But besides these there are other phenomena of a local nature which may be denominated vital, since they depend on the reaction of the living parts (see *ante*, p. 93). I refer now to those indicating the production of inflammation in the tissues in the immediate neighbourhood of those destroyed.

When strong sulphuric acid has been swallowed, the symptoms of poisoning are the following:—Alteration, or even destruction, of the soft parts about the mouth; burning pain in the throat, stomach, and bowels; frequently alteration of the voice, from the swelling and disorganisation of the parts about the larynx; breath fetid, from the decomposed tissues; constant and abundant vomiting of matters which may be bloody or otherwise, but which effervesce by falling on a marble hearth; bowels variously affected, sometimes constipated, though usually purged, the stools being bloody. The constitutional symptoms are principally those arising from depression of the vascular system: thus the pulse is frequent and irregular, feeble, often imperceptible; extremities cold; great feebleness, or even fainting, with cold sweats. The same constitutional symptoms are observed when the stomach is wounded or ruptured (see *ante*, p. 118). One remarkable characteristic is, that the mental faculties are usually unaffected, even up to a few minutes before death.

---

[1] *Toxicologie Générale.*

Not unfrequently the acid fails to produce speedy death from corrosion and inflammation, but gives rise to a peculiar organic disease of the stomach and intestines, of which the patient slowly dies, sometimes after several months' suffering.[1]

USES.—Sulphuric acid, properly diluted, may be administered in *febrile diseases*, as a refrigerant, to diminish thirst and preternatural heat; though, in most of these cases, the vegetable acids are to be preferred. In the latter stage of fever considerable benefit is sometimes gained by the use of a vegetable bitter (as calumba or cinchona) in combination with the diluted sulphuric acid. To assist the appetite and promote digestion, it is administered to patients recovering from fever. *To check profuse sweating* in pulmonary and other affections, whether phthisical or not, it is sometimes a valuable agent. No other remedy is so efficacious in relieving colliquative sweatings as this. In *hemorrhages*, as those from the nose, lungs, stomach, and uterus, it is commonly administered as an astringent, but it is obvious that it can only act as such when it can come in contact with the bleeding surface, as where it is administered in hemorrhage from the stomach. In hemorrhage from the nose, lungs, and uterus, its efficacy is, therefore, doubtful. So also in purpura hæmorrhagica it is given with the same intention; but though I have several times employed it, I have not observed any evident benefit derived therefrom. In those forms of *lithiasis* attended with phosphatic sediments in the urine, the mineral acids are resorted to as acid lithics (see *ante*, p. 262); but as I have before explained (see *ante*, pp. 175–177), these acids cannot enter the blood except in combination with bases, and they are eliminated from the kidneys also in combination. If, therefore, they acidify the urine, it is only indirectly, and by their action on the digestive and assimilating organs. The sulphuric is preferred to the hydrochloric acid, since it can be continued for a longer period without occasioning gastric disorder. In *skin diseases*, especially lichen, prurigo, and chronic nettle-rash, it is sometimes highly serviceable. No remedy is so successful in relieving the distressing itching, formication, and tingling of the skin, as diluted sulphuric acid taken internally. In those forms of *dyspepsia* connected with an alkaline condition of the stomach, as in pyrosis, the sulphuric has been found to succeed better than hydrochloric acid.[2] [Dilute sulphuric acid in full doses, and repeated at short intervals, has been lately strongly recommended by several practitioners in the treatment of cholera. It has also been had recourse to in obstinate diarrhœa. Mr. Cox, of Kensaltown, lays claim to having first recommended this treatment for cholera. His experience agrees in great measure with that of Dr. Fuller, Dr. Millar, and others who have since written on the subject, and on the whole it appears desirable that further trials should be made with the remedy.[3]—ED.]

As a local agent, sulphuric acid is employed as a caustic, irritant, or astringent. As a caustic it has no advantage over many other agents, except that which arises from its liquid form, which, in most cases, renders it disadvantageous. For example, the difficulty of localising it would be an objection to its employment in the production of an issue, but would be an advantage in applying it to wounds caused by rabid animals or poisonous serpents, since the liquidity of the acid enables it to penetrate into all parts of the bites. In entropium, or that disease in which the eyelid is inverted, or turned inwards upon the eye, this acid has been employed as a caustic to destroy a portion of the skin, so that by the subsequent cicatrisation the lid may be turned outwards. This plan of treatment has been practised successfully by several eminent oculists, among whom I may name Mr. Guthrie and Mr. Lawrence. So also in ectropium, in which the lid is everted or turned outward, Mr. Guthrie has applied the concentrated acid to the inner side of the everted lid with advantage. An ointment containing sulphuric acid has been employed as a rubefacient in paralysis, and in the second stage of inflammation of the joints, when the violence of the disease has subsided; as a styptic to wounds, to suppress hemorrhage from numerous small vessels; and as a cure for scabies. Lastly, this acid, properly diluted, is employed as an astringent gargle in ulcerations of the mouth and throat; but after using it the mouth should be well rinsed, to prevent the action of the acid on the teeth.

---

[1] For further information respecting the topical action of sulphuric acid, the reader may consult (besides Dr. Christison's *Treatise on Poisons*) the observations of Dr. R. D. Thomson, in the *Athenæum* for 1840, pp. 779 and 798; *Lancet* for 1836–7, vol. i. p. 195; and Dr. A. S. Taylor, in *Guy's Hospital Reports*, vol. iv., and his work *On Poisons*.

[2] Dr. R. D. Thomson, *British Annals of Medicine*, March 31, 1837.

[3] *Provincial Med. and Surg. Journal*, Sept. 1852; *Lancet*, Oct. 9th and 16th, 1852.

ADMINISTRATION.—For internal use we generally make use of the ***diluted sulphuric acid***, or the ***elixir of vitriol.***

ANTIDOTES.—In cases of poisoning by sulphuric acid, the antidotes are chalk, whiting, or magnesia, suspended in water. In the absence of these, soap-suds, infusion of wood-ashes, weak solutions of the alkaline carbonates, white of eggs, gelatine, milk, oil, or in fact any mild diluent, should be immediately administered (see *ante*, p. 164). The subsequent treatment is that for gastro-enteritis. External parts burnt with oil of vitriol should be washed with a solution of soap or simple water.

1. ACIDUM SULPHURICUM DILUTUM, L. E. D.; *Diluted Sulphuric Acid; Spirit of Vitriol*, or *Spiritus Vitrioli tenuis; Vitriol to clean Copper.* (Sulphuric Acid, f℥xv. [f℥j. *E.* and *D.*]; Distilled Water, Oj. [f℥xiij., *E.* and *D.*] Mix. When the acid and water are mixed, condensation ensues, and heat is evolved.)—The white precipitate which forms is sulphate of lead. The *London College* orders the acid to be added by degrees to Oss. of water, and then the remaining water added so as to make up Oj. It is much to be regretted that the formulæ of the British Colleges for the preparation of this acid should not have been uniform. [The Edinburgh and Dublin agree.—ED.]

According to Mr. Phillips, the sp. gr. of this dilute sulphuric acid, *Ph. Lond.*, is 1·103; and a fluidounce of it contains 60 grains of real acid, and will saturate 216 grs. of crystallised carbonate of soda. A fluidounce of this acid will, therefore, weigh 482·5 grs.

	By weight.
Anhydrous sulphuric acid	12·43
Water	87·57
Acidum sulphuricum dilutum, *Ph. L.*...	100 00

	By weight.
Strongest oil of vitriol	15·23
Water	84·77
Acidum sulphuricum dilutum, *Ph. L.*	100·00

The density of the Edinburgh and the Dublin diluted sulphuric acid is 1·090. The comparative strength, by weight, of this and the London preparation is as about 100 to 70: by volume the difference is still greater. The dose of diluted sulphuric acid is from ♏x. to ♏xxx. or ♏xl., diluted with two or three table-spoonfuls of some mild liquid. A most convenient preparation of it is the compound infusion of roses (*Infusum Rosæ Compositum*). It may also be exhibited in conserve of roses.

2. ACIDUM SULPHURICUM AROMATICUM, E. D.; *Aromatic Sulphuric Acid; Elixir of Vitriol*, or *Acid Elixir of Vitriol*. (The *Edinburgh College* orders of Sulphuric Acid (commercial), f℥iiiss.; Rectified Spirit, Oiss.; Cinnamon, in moderately fine powder, ℥iss.; Ginger, in moderately fine powder, ℥j. Add the acid gradually to the spirit; let the mixture digest at a very gentle heat for three days in a closed vessel; mix the powders, moisten them with a little of the acid spirit, let the mass rest for twelve hours, and then put it into a percolator, and transmit the rest of the acid spirit. This preparation may also be made by digesting the powders for six days in the acid spirit, and then straining the liquor. The *Dublin College* orders of Rectified Spirit, Oiss.; Sulphuric Acid, f℥iiiss.; Cinnamon Bark, bruised, ℥iss.; Ginger root, bruised, ℥j. Upon the spirit, placed in a stoppered bottle, pour the acid gradually, and shake so as to produce a uniform mixture. Then add the cinnamon and ginger, and macerate for a week with occasional agitation. Lastly, filter through paper, and preserve in a well-stopped bottle. The specific gravity of this preparation is ·974).—It is employed as an agreeable substitute for the diluted sulphuric acid, and is administered in the same doses. In a case of poisoning by ten drachms of this preparation, the symptoms were those of local irritation, with vomiting and purging of blood. The patient recovered.[1] Its uses are the same as the acid before mentioned. Dose, twenty drops thrice daily.

12. ACIDUM SULPHUROSUM.—SULPHUROUS ACID.

Formula SO^2. *Equivalent Weight* 32. *Equivalent Volume* 1 or □

HISTORY.—Homer[2] mentions sulphur fumigations. Stahl, Scheele, and Priestley, were the first to submit this acid to an accurate examination. It has been termed *phlogisticated sulphuric acid*, or *volatile sulphuric acid*.

NATURAL HISTORY.—It escapes from the earth, in a gaseous form, in the neighbourhood of volcanoes.

PREPARATION.—For chemical purposes it is prepared by mixing two parts of copper filings or mercury with three parts of strong sulphuric acid, applying heat, and collecting over mercury. The results are sulphate of copper or bipersulphate of mercury and water and sulphurous acid, $Cu + 2(HO,SO^3) = CuO,SO^3 + 2HO + 2SO^2$.

For medicinal purposes, however, it is rarely, if ever, necessary to procure it in this way. By the combustion of sulphur in atmospheric air this gas is readily obtained; and when we are about to employ it, either as a disinfectant or as a vapour bath, this method is always followed. $S + O^2 = SO^2$.

PROPERTIES. α. *Of the gaseous acid.*—At ordinary temperatures and pressures it is a colourless and transparent gas, and has a remarkable and well-known odour—that of burning brimstone. It is neither combustible nor a supporter of combustion. It reddens litmus and bleaches some colouring matters, especially infusion of roses, but the colour is restored by sulphuric acid. It is irrespirable, and has a sp. gr. of 2·2. It readily dissolves in water: recently boiled water takes up 33 times its volume of this gas.

---

[1] *London Medical Gazette*, vol. xxv. p. 944.

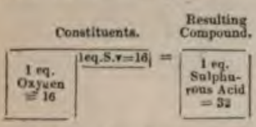
[2] *Iliad*, xvi. 228.

The solution (*aqua acidi sulphurosi*) was formerly called *spirit of sulphur by the bell* (*spiritus sulphuris per campanam*), on account of the method of procuring it.

β. Of the liquid acid.—Obtained by subjecting the gaseous acid to the united influence of cold and pressure. It is a limpid liquid, having a sp. gr. of 1·42, Faraday (1·45, Bussy). It boils at 14° F. It dissolves bitumen.

γ. Of the solid acid.—Liquid sulphurous acid becomes a crystalline, transparent, colourless body at $-105°$ F.

Characteristics.—This acid is readily known by its peculiar odour—that of burning sulphur. If the puce-coloured or binoxide of lead be added to it, the white protosulphate of lead is formed. An aqueous solution of this acid, mixed with iodic acid, deoxidises the latter, and sets iodine free, which may be recognised by its producing a blue colour with starch. It decomposes sulphuretted hydrogen, causing the precipitation of sulphur, and reduces solutions of gold. A solution of an alkaline sulphite causes, with a soluble salt of barium, a white precipitate (*sulphite of baryta*). The sulphites evolve sulphurous acid by the action of strong sulphuric acid.



Composition.—If 16 parts by weight of sulphur be burned in one volume or 16 parts (by weight) of oxygen gas, we obtain one volume or 32 parts (by weight) of sulphurous acid gas.

The composition of this substance may, therefore, be thus expressed:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Berzelius.*		*Vol.*
Sulphur	1	 16	 50	...... 49·968	Sulphur vapour	$\frac{1}{6}$
Oxygen	2	 16	 50	...... 50·032	Oxygen gas	1
Sulphurous Acid...	1	 32	 100	...... 100·000	Sulphurous Acid Gas ...	1

Physiological Effects. *α. On Vegetables.*—It is a most powerful poison to plants, even in very minute quantities.[1]

β. On Animals generally.—The effects on animals have not been examined, but they are probably those of an irritant and asphyxiating agent.

γ. On Man.—Applied to the skin, this acid gas causes heat, pain, and itching. If an attempt be made to inhale it in the pure state, it excites spasm of the glottis (see *ante*, p. 117). Diluted with air, it may be taken into the lungs, and there acts as a local irritant, causing cough, heat, and pain.

Uses.—It has been used as a disinfectant, as a remedy for the cure of itch, and as a nasal stimulant in syncope.

As a *disinfectant* it is mentioned by Homer. The mode of using it for this purpose is very simple. A pot containing burning sulphur is introduced into the room or place to be fumigated, and the doors and windows carefully closed.

As a remedy for itch, baths of sulphurous acid gas are mentioned by

---

[1] Christison, *On Poisons*, 3d edit. p. 750.

Glauber in 1659. They are commonly termed *sulphur baths*, and may be had at most of the bathing establishments of the principal towns of this country. At the Hôpital St.-Louis, in Paris, a very complete apparatus for the application of this remedy in diseases of the skin has been erected by D'Arcet.[1] It is a kind of box, inclosing the whole body, with the exception of the head. The sulphur is placed on a heated plate in the lower part of the box. From ten to twenty baths, or even more, are requisite for the cure of itch. "Sulphurous fumigations," says Rayer,[2] "which are employed in some hospitals, are not attended with expense, leave no unpleasant smell, and do not soil the linen; but the long continuance of the treatment necessary to relieve the disease more than counterbalances these generally insignificant recommendations." There are various other diseases of the skin in which baths of sulphurous acid have been found more or less successful, such as chronic eczema, lepra, psoriasis, impetigo, and pityriasis.[3]

As a stimulant in syncope or asphyxia, this gas has been recommended by Nysten. It is readily applied by holding a burning sulphur match under the nose.

ANTIDOTES.—When sulphurous acid gas has been inhaled, the patient should be made to respire the vapour of ammonia. A few drops of the solution of this substance should be swallowed.

13. Acidum Hydrosulphuricum.—Hydrosulphuric Acid.

Formula HS. *Equivalent Weight* 17. *Equivalent Volume* 1 or □

Sulphuretted hydrogen (*hydrogenium sulphuratum*); *Hydrothion* (θεῖον, *sulphur*); *Hydrothionic acid*; *Hepatic air* (*äer hepaticus*).—Discovered by Scheele in 1777, though Meyer and Ruellius had previously observed it. It is an ingredient in the sulphurous waters (see *ante*, p. 308); its origin in these cases being probably referable to the action of water or watery acids on metallic sulphurets. In marshy and stagnant waters, and in common waters which have been bottled, it is frequently produced by decomposition of sulphates (especially gypsum) effected by putrescent organic matter (see *ante*, p. 72). Many sulphuretted organic matters evolve it during their decomposition, as eggs, night-soil, &c.

It is usually obtained by the action of dilute sulphuric acid on protosulphuret of iron, $HO,SO^3+FeS=HS+FeO,SO^3$; or by the action of hydrochloric acid on black sulphuret of antimony, $3HCl+SbS^3=3HS+SbCl^3$.

It is a colourless, transparent gas, having the odour of rotten eggs, and a sp. gr. of 1·17. It reddens litmus, and burns in the air with a bluish flame, the deposition of sulphur on the sides of the glass vessel in which it is burned, and the disengagement of sulphurous acid. It blackens white lead and solutions of the salts of lead, copper, and bismuth. When mixed with 20,000 vols. of air, hydrogen, or carburetted hydrogen, its presence may be detected by the discolouration it effects in white lead mixed with water and spread on a card. Under a pressure of 17 atmospheres at 50° F., the gas condenses into a limpid liquid, whose sp. gr. is about 0·9. This liquid freezes at −122° F., and forms a white, crystalline, translucent substance. Hydrosulphuric acid consists of 16 parts, by weight, of sulphur to 1 of hydrogen.

---

[1] *Description des Appareils à Fumigations établis sur ses Dessins à l'Hôpital Saint-Louis en* 1814, *et successivement dans plusieurs Hôpitaux de Paris, pour le Traitement des Maladies de la Peau*, Paris, 1818.

[2] *Treatise on Diseases of the Skin*, by Dr. Willis, p. 347.

[3] For further information on this subject, consult *Mémoire et Rapports sur les Fumigations Sulfureuses*, par J. C. Galés, 1816; *Observations on Sulphurous Fumigations*, by W. Wallace; *An Essay on Diseases of the Skin*, by Sir A. Clarke.

In chemical investigations hydrosulphuric acid is important and valuable, both as a test and as a separating agent. In toxicological inquiries, therefore, it is in common use (see the article *Arsenious Acid*).

It is a poison to both plants and animals when diffused through the air in which they are placed. Curiously enough, however, the vegetation in the neighbourhood of sulphurous springs is usually luxuriant; so that it would appear to act beneficially when placed within reach of the roots of plants.[1]

The respiration of the undiluted gas proves fatal to animals. It becomes absorbed, blackens the blood, and destroys the powers of life. It probably acts as a chemical agent on the blood: Liebig thinks it converts the iron of the blood into a sulphuret. MM. Thénard and Dupuytren state that air which contains $\frac{1}{1500}$th of this gas destroys a bird in a very short time: that which contains $\frac{1}{800}$th kills a dog, and that a horse dies in an atmosphere containing $\frac{1}{250}$th part of it. But these statements are probably exaggerated; for rats and other vermin live in large numbers in drains and sewers which are contaminated with this gas (according to Gaultier de Claubry, these localities contain from two to eight per cent. of it.) On man it acts, when inspired, most injuriously. In the undiluted state it would probably prove fatal. When moderately diluted, its respiration causes immediate insensibility, with depression of all the powers of life. Still more diluted, it causes convulsions; and when air is but slightly contaminated with it, it causes nausea or sickness, debility, and headache. Various ill, or even fatal, effects produced by emanations from decomposing organic matters, and which have been loosely ascribed to sulphuretted hydrogen, may be in part owing to other gaseous substances (see *ante*, p. 166) at present undistinguished by their chemical, or, in some cases, even by their sensible properties. Parent-Duchâtelet says that workmen can breathe with impunity an atmosphere containing $\frac{1}{100}$th of sulphuretted hydrogen: he himself has respired, without serious symptoms, air containing $\frac{1}{33}$d of it.—It deserves especial notice that this poison is less active when applied to any other part of the body (even, according to Orfila, when introduced into the jugular vein) than when respired. That its activity is very considerably less when introduced into the alimentary canal, must be very obvious when we consider the freedom and impunity with which sulphuretted waters are drunk, and the fact that sulphuretted hydrogen is frequently developed in the intestinal tube without any known ill effects. Before its absorption from the alimentary canal, it probably undergoes some chemical change—perhaps forms with the soda of the bile sulphuret of sodium and water (see the article *Sulphurosa*, p. 187).

Sulphuretted hydrogen gas has been employed in medicine; but its use requires great caution. The inhalation of air slightly impregnated with it has been employed to lessen the irritability and excitability of the lungs in chronic inflammation and phthisical affections of these organs. The benefit which, according to Galen, pulmonary invalids obtained by travelling in Sicily, has been ascribed to the presence of sulphur in the atmosphere; and it has been stated that in the neighbourhood of sulphur springs,—those of Aix-la-Chapelle, for example,—phthisis is less prevalent than in other places. Local baths of sulphuretted hydrogen gas, or of aqueous vapour impregnated with this gas, have been employed with benefit in obstinate rheumatic and gouty affections and chronic cutaneous affections.

As a medicine it is rarely employed except in the form of the sulphurous mineral waters (see *ante*, p. 308). An aqueous solution of it, artificially prepared, is, however, sometimes used.

AQUA ACIDI HYDROSULPHURICI; *Aqua Hydrosulphurata; Acidum Hydrosulphuricum Aquâ solutum; Sulphuretted Hydrogen Water.*—This is prepared by passing sulphuretted hydrogen gas into cold distilled water until it ceases to be absorbed; or, better still, by passing sulphuretted hydrogen into a bottle filled with distilled water, and inverted over the pneumatic trough, until two-thirds of the water are displaced. Then stopper the bottle, and shake, that the gas may be absorbed by the water in the bottle. Preserve the solution in a bottle completely filled with it.

At ordinary temperatures and pressures, water absorbs two or three volumes of this gas. The solution has the smell of the gas, and a nauseous, sulphurous taste. By exposure to the air it becomes decomposed; its hydrogen being oxidised, and converted into water, and its sulphur precipitated.

This solution is chiefly employed for chemical and toxicological purposes.

---

[1] Johnston's *Lectures on Agricultural Chemistry*, 2d edit. 1847.

The general effects of sulphuretted hydrogen water, taken in small doses, are those of the *sulphurosa* before mentioned (see *ante*, p. 187). It promotes and improves the secretions of the mucous surfaces, the skin, and the glands; and is considered to have a specific influence over the liver and portal system, including the hemorrhoidal vessels. Thus its sensible effects are those of an aperient, expectorant, sudorific, cholagogue, diuretic, and emmenagogue. It is useful in medicine as an alterative and resolvent. Lessmann[1] describes sulphuretted hydrogen as being a stimulant to the vascular system, to the nerves, and to the secreting organs.

Sulphuretted hydrogen water sometimes occasions nausea and vomiting. Taken in large quantities it becomes absorbed, and operates as a narcotic poison, producing effects similar to those caused by its inhalation. It would appear, therefore, that moderate quantities when swallowed undergo a kind of digestion and assimilation (as above alluded to); but that large quantities are absorbed unaltered, and act as a poison.

Sulphuretted hydrogen water has been used as an antidote in poisoning by the salts of lead. Its efficacy consists in its converting the lead salt into a sulphuret of lead. It has also been employed to check mercurial salivation. It is only adapted for maladies of a chronic character—principally cutaneous, rheumatic, gouty, syphilitic, bronchial, hepatic, and hemorrhoidal affections.

When administered as an antidote, it may be given in doses of a wine-glassful, at intervals of from a quarter of an hour to an hour, according to circumstances. In other cases it is given to the extent of from half a wine pint to a pint during the day. A little essence of peppermint may be taken as a corrective. It is sometimes administered with carbonic acid or Selters water.

Externally, sulphuretted hydrogen water has been used as a wash or bath. In general, however, a solution of sulphuret of potassium or of sulphuret of calcium is employed as a substitute. (See *Balneum sulphuratum*.)

Hahnemann's test liquor (*liquor probatorius Hahnemanni*) for detecting the presence of lead in wine is prepared by adding a drachm of tartaric acid to four ounces of sulphuretted hydrogen water. It is, therefore, an acidulated sulphuretted hydrogen water (*aqua hydrosulphurata acidula*).

14. Carbonii Bisulphuretum.—Bisulphuret of Carbon.

Formula CS^2. *Equivalent Weight* 38. *Equivalent Volume of Vapour* 1 or □

Sulphide of Carbon; Carburet of Sulphur; Alcohol of Sulphur, or *Sulphuris Alcohol.*—Discovered in 1796 by Lampadius.[2] It was at first supposed to be a compound of sulphur and carbon. It is obtained by passing the vapour of sulphur over red-hot charcoal, and condensing the vapour of the bisulphuret either in a receiver cooled to 32° F., or in ice-cold water.[3] It may also be procured by distilling a mixture of iron pyrites (FeS^2) and charcoal.[4] At ordinary temperatures, sulphur and carbon are without action on each other; but when sulphur vapour comes in contact with glowing carbon, combination takes place, and the bisulphuret of carbon is formed. The product requires to be rectified by redistillation. If it be required free from water, it must be redistilled from chloride of calcium.

Bisulphuret of carbon is a highly refractive, limpid, colourless liquid, whose odour is fetid and somewhat analogous to that of putrid cabbage. It is extremely volatile, and produces intense cold by its evaporation. Its taste is pungent and hot. It is heavier than water, having a sp. gr. of 1·272. It boils at 106° F., and freezes at −60° F. It is very combustible, burning in the air with a pale blue flame, and disengaging sulphurous and carbonic acids. It is insoluble in water, but is soluble in alcohol, ether, the volatile and the fixed oils. It dissolves sulphur, iodine, phosphorus, camphor, caoutchouc, and some resins. It combines with the basic sulphurets, forming a sulphocarbonate. Thus when it is mixed with caustic potash the products are carbonate of potash and the sulphocarbonate of potassium, $3KO+3CS^2=KO,CO^2+2(KS,CS^2)$.

---

[1] *De Aeris Hydrothionici usu medico*, diss. inaug. med. Berol. 1830.

[2] Lampadius has subsequently described the preparation, properties, and therapeutical applications of this agent, in a monograph entitled *Ueber den Schwefelalkohol*, &c. Freib. 1826; 2te Aufl. Freib. 1833.

[3] Various forms of apparatus have been employed in this process. Several of these are figured in L. Gmelin's *Handbuch*. A convenient apparatus is also described by Wittstein (*Ueber die Darstell. u. Prüf. chem. u. pharm. Präparate*, Münch. 1845).

[4] Minute quantities of bisulphuret of carbon have been detected in coal gas. The injury sustained by the bindings of books in the libraries of the London Institution and Athenæum Club, appears to be in part referable to the action of an acid compound of sulphur formed by the combustion of coal gas (see *Pharmaceutical Journal*, vol. vi. p. 584). This compound is probably the product of the combustion of the bisulphuret of carbon contained in the gas.

It is characterised by its odour, its sp. gr., its high refractive power, the colour of its flame and the products of its combustion, its insolubility in water, and by the action of iodine on it. $\frac{1}{1000}$th of its weight of iodine dissolves in it, yielding an amethystine or bluish-red solution: $\frac{1}{200}$th part yields a pale rose-red solution.

It consists of 15·79 per cent. of carbon and 84·21 per cent. of sulphur; or 1 atom = 6 of carbon, and 2 atoms = 32 of sulphur.

Its purity is recognised by the following characters:—It should be limpid, colourless, completely volatile (not leaving a residue of sulphur or other solid matters when submitted to evaporation), and not darken white lead (by which the absence of sulphuretted hydrogen is shown).

Bisulphuret of carbon is allied in its action on the system to sulphuric ether. By some it is considered intermediate between ether and ammonia. It is an acrid or local irritant (see *ante*, p. 168), a diffusible stimulant (see *ante*, p. 222), a narcotic or stupefacient (see *ante*, p. 205), and an anæsthetic (see *ante*, p. 208). It agrees with ether, also, in the circumstance that by its evaporation it produces intense cold. It augments the frequency of the heart's action, and acts as a powerful sudorific. Diuretic and emmenagogue effects have also been ascribed to it. If the vapour of it be applied to the shut eye for a minute or two, it generally causes contraction, seldom dilatation, of the pupil.[1]

As a topical remedy, it has been used as a cooling agent, by evaporation, and as a stimulant and resolvent. Internally, it has been employed as a stimulant, analeptic, or restorative (see *ante*, p. 223), as a sudorific, emmenagogue, ecbolic (see *ante*, p. 270), and anæsthetic (see *ante*, p. 208).

Bisulphuret of carbon has been employed as an analeptic or restorative in fainting, hysterical fits, and in asphyxia. In these cases its vapour, like that of ammonia, is applied to the nose, or, when the patients are able to swallow, a few drops are administered by the stomach every ten minutes. It has also been used to relieve intoxication.

In rheumatic and gouty affections it has been administered internally as a powerful stimulant and sudorific, and applied externally as a counter-irritant and resolvent.

It has also been employed as a sudorific and alterative in cutaneous affections; as an emmenagogue in amenorrhœa; as an ecbolic in feeble uterine contractions; as a local resolvent in glandular swellings; as a sorbefacient in goître, and in many other cases.[2]

Very recently it has been tried as an anæsthetic by Dr. Simpson.[3] His account of its effects is as follows:—

"It has been stated in various literary journals, that bisulphuret of carbon has lately been used as an anæsthetic agent at Christiana; but no particulars regarding its employment in Norway have, as far as I know, been yet published.

"I have breathed the vapour of bisulphuret of carbon, and exhibited it to about twenty other individuals, and it is certainly a very rapid and powerful anæsthetic. One or two stated that they found it even more pleasant than chloroform; but in several it produced depressing and disagreeable visions, and was followed for some hours by headache and giddiness, even when given only in small doses. In one instance I exhibited it, with Mr. Miller's permission, to a patient from whom he removed a tumour of the mamma. It very speedily produced a full anæsthetic effect; but it was difficult to regulate it during the operation. The patient was restless in the latter part of it, but felt nothing. Like several others when under it, her eyes remained wide open. After the operation she was extremely sick, with much and long-continued headache; and for fifty or sixty hours subsequently her pulse was high and rapid, without rigor or symptoms of fever.

---

[1] Dr. Turnbull, *London Medical Gazette*, Nov. 5, 1842.

[2] For notices of some of its other uses, the reader is referred to Richter's *Ausführliche Arzneimittellehre*, Bd. iii. S. 464, and Bd. vi. S. 457; Riecke, *Die neueren Arzneimittel*. 2te Aufl. 1840; Dunglison's *New Remedies*, 1843; and Aschenbrenner, *Die neueren Arzneimittel*, Erlangen, 1848.

[3] *Pharmaceutical Journal*, vol. vii. p. 517.

"I tried its effects in a case of midwifery, in presence of Dr. Weir, Dr. Duncan, Mr. Norris, and a number of the pupils of the Maternity Hospital. It was employed at intervals during three-quarters of an hour. The patient was easily brought under its influence, a few inspirations sufficing for that purpose; but it was found altogether impossible to produce by it the kind of continuous sleep attending the use of chloroform. Its action was so strong, that when given, as a pain threatened or commenced, it immediately affected the power of the uterine contractions, so as often to suspend them; and yet its effects were so transient that the state of anæsthesia had generally passed off within a minute or two afterwards. The patient anxiously asked for it at the commencement of each pain. During its use she was occasionally sick, and vomited several times. Latterly her respiration became rapid, and her pulse rose extremely high. I then changed the inhalation for chloroform, and under it the patient slept quietly on for twenty minutes, when the child was born. During these twenty minutes there was no more sickness or vomiting, and the pulse gradually sank down to its natural standard; and a few minutes after the child was expelled, and while the mother still slept, her pulse was counted at 80. Next day the mother and infant were both well, and she has made a good recovery."

Dr. Snow[1] has tried the effect of its vapour when diffused through air on mice. He says that it does not cause muscular relaxation prior to death; but tremulous convulsions continue till death, which seems to be threatened almost as soon as complete insensibility to external impressions is established. Dr. Snow thinks that a single deep inspiration of air saturated with its vapour, at a summer temperature, would produce instant death.

Bisulphuret of carbon is administered internally in doses varying from two to six, or more, drops taken on sugar; or dissolved in four times its volume of ether or alcohol; or mixed with milk or mucilaginous decoctions.

Externally, it is employed in the form of embrocation or liniment, composed of one part bisulphuret and two parts of almond or olive oil, or of alcohol. Sometimes one part of camphor is dissolved in two parts of the bisulphuret, and the solution mixed with four parts of alcohol.

ORDER VII. CHLORINE AND ITS COMBINATIONS WITH HYDROGEN AND SULPHUR.

15. CHLORINIUM.—CHLORINE.

Symbol Cl. *Equivalent Weight* 35·5. *Equivalent Volume* 1 or □

HISTORY.—This gas was discovered by Scheele in 1774, who termed it *dephlogisticated muriatic acid.* Berthollet, in 1785, named it *oxygenated muriatic acid.* Sir H. Davy called it *chlorine* (from χλωρός, *green*), on account of its colour.

NATURAL HISTORY.—It is found in both kingdoms of nature.

α. IN THE INORGANISED KINGDOM it exists principally in combination with sodium, either dissolved in the water of the ocean or forming deposits of rock salt. Chlorine also occurs in combination with magnesium, calcium, lead, silver, &c. Free hydrochloric acid is met with in the neighbourhood of volcanoes, and is probably produced by the decomposition of some chloride.

β. IN THE ORGANISED KINGDOM it is found, in combination, in both animals and vegetables. Sprengel[2] says, maritime plants exhale chlorine principally during the night. Hydrochloric acid, in the free state, exists, according to Dr. Prout, in the stomach of animals during the process of digestion.

---

[1] *Lond. Med. Gaz.* June 23, 1848.

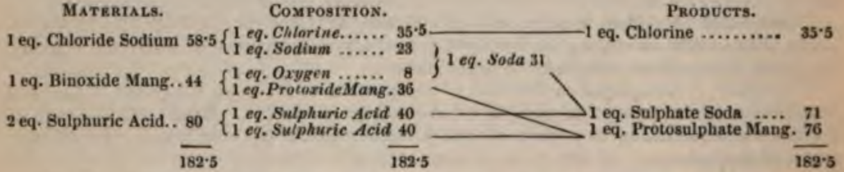
[2] De Candolle, *Physiol. Végét.* tom. i. p. 220.

PREPARATION.—There are several methods of procuring chlorine gas:—

1. *By adding diluted sulphuric acid to a mixture of common salt and binoxide of manganese.*—This is the cheapest and most usual way of preparing it. Mix intimately three parts of dried common salt with two parts of the binoxide of manganese, and introduce the mixture into a retort. Then add as much sulphuric acid, previously mixed with its own weight of water, as will form a mixture of the consistence of cream. (Brande directs 8 salt, 3 manganese, 4 water, and 5 acid; Thénard, 1½ salt, 1 manganese, 2 acid, and 2 water; Graham, 8 salt, 6 manganese, and dilute acid as much as contains 13 parts of oil of vitriol.)

On the application of a gentle heat, the gas is copiously evolved, and may be collected over either warm or cold water.[1]

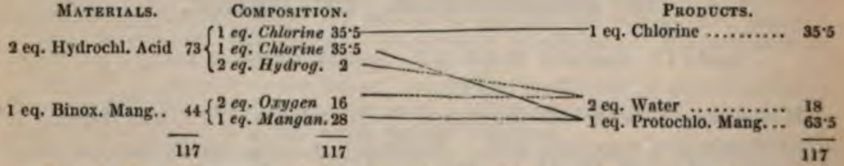
In this process two equivalents of sulphuric acid react on one equivalent of the binoxide and on one equivalent of chloride of sodium, and yield one equivalent of chlorine, one equivalent of the sulphate of the protoxide of manganese, and one equivalent of sulphate of soda, $MnO^2 + NaCl + 2SO^3 = MnO,SO^3 + NaO,SO^3 + Cl$.



MATERIALS.		COMPOSITION.			PRODUCTS.	
1 eq. Chloride Sodium	58·5	*1 eq. Chlorine*	35·5		1 eq. Chlorine	35·5
		1 eq. Sodium	23	*1 eq. Soda 31*		
1 eq. Binoxide Mang.	44	*1 eq. Oxygen*	8			
		1 eq. ProtoxideMang.	36			
2 eq. Sulphuric Acid.	80	*1 eq. Sulphuric Acid*	40		1 eq. Sulphate Soda	71
		1 eq. Sulphuric Acid	40		1 eq. Protosulphate Mang.	76
	182·5		182·5			182·5

2. *By heating a mixture of equal weights of common hydrochloric acid and binoxide of manganese in a glass retort over a lamp.*

In this process two equivalents of hydrochloric acid react on one equivalent of the binoxide, and yield one equivalent of chlorine, two equivalents of water, and one equivalent of protochloride of manganese, $MnO^2 + 2HCl = MnCl + 2HO + Cl$.



MATERIALS.		COMPOSITION.		PRODUCTS.	
2 eq. Hydrochl. Acid	73	*1 eq. Chlorine*	35·5	1 eq. Chlorine	35·5
		1 eq. Chlorine	35·5		
		2 eq. Hydrog.	2		
1 eq. Binox. Mang.	44	*2 eq. Oxygen*	16	2 eq. Water	18
		1 eq. Mangan.	28	1 eq. Protochlo. Mang.	63·5
	117		117		117

3. *By the action of sulphuric or hydrochloric acid on chloride of lime.*—This method may be resorted to when binoxide of manganese cannot be procured. The products of the reaction of the ingredients are—chlorine, water, and either sulphate of lime or chloride of calcium, according as sulphuric or hydrochloric acid has been employed. When sulphuric acid is employed, the equation is as follows:—$(CaCl + CaO,ClO) + 2SO^3 = 2(CaO,SO^3) + 2Cl$.

[With reference to this subject, we have found the following note among the papers of the late Dr. Pereira:—

"Visited Tennant's chemical works. Chlorine made by Dunlop's patent, without the use of oxide of manganese. The ingredients were $NaCl + NaO,NO^5 + SO^3,HO$. The volatile products $Cl + NO^4$ were transmitted through oil of vitriol. This retained the NO^4, and the solution was used for making oil of vitriol. The Cl which passed on was used for making chloride of lime, and the residual sulphate of soda was used for making the carbonate. The process, or rather the apparatus, appeared very complicated."—ED.]

---

[1] For further information respecting the commercial mode of preparing chlorine, see *Hypochlorite of Lime.*

PROPERTIES. α. *Of gaseous chlorine.*—Chlorine, at ordinary temperature and pressure, is a gaseous substance, having a yellowish-green colour, a pungent suffocating odour, and an astringent taste. Its sp. gr., according to Gay-Lussac, is 2·47. It is not combustible, but is a supporter of combustion. Phosphorus and powdered antimony take fire spontaneously when introduced into it; and a taper burns in it, with the evolution of a red light and much smoke. When water is present it destroys vegetable colours, organic odours, and infectious matters. Hence its use as a bleaching agent, a deodoriser, and a disinfectant (see *ante*, p. 166).

β. *Of liquid chlorine.*—By a pressure of 4 atmospheres, at the temperature of 60° F., chlorine is a yellow liquid, having a sp. gr. of 1·33 (water being 1·0). Faraday could not freeze it at −166° F.

Characteristics.—The colour and odour of chlorine readily distinguish it from other gases. Free chlorine decolorises a solution of sulphate of indigo. It forms a white curdy precipitate (*chloride of silver*) with the nitrate of silver:[1] this precipitate blackens by exposure to light (from the escape of some chlorine and the formation of a subchloride of silver[2]); is insoluble in nitric acid, cold or boiling; readily dissolves in liquid ammonia; when heated in a glass tube, fuses, and, on cooling, concretes into a grey semi-transparent mass (*horn silver* or *luna cornea*); and lastly, when heated with potash, it yields metallic silver and a chloride of potassium.

Hydrochloric acid and the soluble metallic chlorides, like free chlorine, yield a white precipitate of chloride of silver on the addition of nitrate of silver.

Bromate, bromide, iodate, and iodide of silver, like chloride of silver, are insoluble in dilute nitric acid.

Nitrate of silver does not occasion a precipitate in a solution either of a perchlorate or a chlorate.

Free chlorine bleaches a solution of sulphate of indigo. By this test it may be distinguished both from hydrochloric acid and the chlorides. If, however, hydrochloric acid or a soluble chloride be added to water coloured blue by sulphate of indigo, and the solution be submitted to the action of a galvanic battery, chlorine is evolved at the anode or positive pole, and bleaches the indigo in its immediate neighbourhood.

Hypochlorous acid (ClO) and the alkaline hypochlorites, as also hypochloric acid (ClO^2), possess bleaching properties like chlorine. The odour of these two oxides of chlorine is, however, very different from that of pure chlorine. "Hypochloric acid gas may be distinguished from chlorine, because its bleaching power is not destroyed by a solution of arsenious acid in muriatic acid" (Peligot).

An aqueous solution of chlorine dissolves leaf-gold. The chlorides, when heated with oil of vitriol, evolve hydrochloric acid.

---

[1] Some hypochlorite of silver (which is subsequently converted into chloride and chlorate of silver) is probably also formed.

[2] Wetzlar, in Landgrebe's *Versuch über das Licht*, p. 53, 1834.

Physiological Effects. α. *On Vegetables.*—The germination of seeds has been said to be promoted by watering them with a weak solution of chlorine;[1] but the statement is probably erroneous.

β. *On Animals generally.*—Nysten[2] injected a small quantity of chlorine gas into the jugular vein of a dog, and the only effect was howling. A larger quantity occasioned difficult respiration, apparently great agony, and death in three minutes. The body was opened four minutes afterwards: the blood was fluid and venous in the auricles and ventricles, which contained neither gas nor coagula. On another occasion he threw this gas into the pleura, and thereby produced inflammation of this membrane and death. From these experiments Nysten[3] concludes that it is a local irritant, but has no specific effect on any part of the system.

γ. *On Man.*—Chlorine gas acts as a *local* irritant. Its chemical agency has been before alluded to (see *ante*, p. 96). Mr. Wallace[4] tells us that diluted with air or aqueous vapour of 116° F., and applied to the skin, it produces peculiar sensations, similar to those caused by the bite or sting of insects: this effect is accompanied with copious perspiration, and a determination of blood to the skin, sometimes attended with an eruption of minute papulæ, or even vesicles. Applied to the skin in a pure form, its action is similar, but more energetic.

If an attempt be made to inspire undiluted chlorine gas, it produces spasm of the gottis (see *ante*, p. 117). If the gas be mixed with air, it enters into the bronchial ramifications, causes a sensation of tightness and suffocation, and violent cough. Twice I have suffered most severely from the accidental inhalation of it; and each time it gave me the sensation of constriction of the air-tubes, such as might be produced by a spasmodic condition of the muscular fibres of the bronchial tubes. The attack usually goes off in increased secretion from the mucous membrane. When diluted with a large quantity of air, chlorine may be inhaled without exciting cough: it occasions a sensation of warmth in the respiratory passages, and promotes expectoration.

The irritating effects of chlorine are less powerful on those accustomed to inhale it, as I have repeatedly seen in patients who were using the gas, and which is also proved by the following statement, made by Dr. Christison:[5]—"I have been told (says he) by a chemical manufacturer at Belfast, that his workmen can work with impunity in an atmosphere of chlorine where he himself could not remain above a few minutes."

The constitutional or *remote* effect caused by inhalations of chlorine, is increased frequency of the pulse and of respiration. But this effect may be in part owing to the augmented muscular efforts of the patient. Mr. Wallace states that the application of chlorine to the skin also occasions soreness of the mouth, fauces, and œsophagus, increased vascularity, and even minute ulcerations of these parts, and an alteration in the quantity and quality of the salivary and biliary secretions. He thinks that it has a tranquillising, and at the same time exciting, power with respect to the nervous system. It would appear, from the observations of Professor Albers,[1] that though the topical action of chlorine is stimulating, yet the remote action is antiphlogistic; for it diminished the frequency of the pulse, calmed excitement, and produced effects which may be termed antiphlogistic. Dr. Christison tells us that at the Belfast manufactory above alluded to the chief consequences of exposure to an atmosphere of chlorine are acidity and other stomach complaints, which the men generally correct by taking chalk. Absorption of fat is also an effect observed in the manufactories at Glasgow, Manchester, and Belfast.[2]

---

[1] De Candolle, *Physiologie Végétale*, t. ii. p. 632.

[2] *Recherches*, p. 140.

[3] *Op. cit.* p. 143.

[4] *Researches respecting the Medical Powers of Chlorine, particularly in Diseases of the Liver*, Lond. 1822.

[5] *Treatise on Poisons*, p. 736.

When applied to the skin or bronchial membrane, chlorine gas probably becomes absorbed; for Mr. Wallace found that the urine acquired bleaching properties under its use.

USES.—α. *As a fumigating agent, disinfectant,* and *antiseptic,* chlorine, I believe, stands unrivalled (*fumigatio chlorinii, oxymuriatica* seu *Guytoniana*). Hallé, in 1785, appears to have been the first person who employed it as a disinfectant; but we are greatly indebted to Guyton-Morveau for the zeal and energy he manifested in his attempts to introduce it into use. For destroying miasmata, noxious effluvia, and putrid odours, it is the most powerful agent known; and is, therefore, well adapted for disinfecting prisons, ships, hospitals, dissecting-rooms, and all other places the air of which requires purification. The ingredients for producing the gas should be contained in saucers placed in the higher parts of the room, as the gas which is developed will descend by its density, and soon become mixed with the surrounding air.—The following is the method adopted by Dr. Faraday at the General Penitentiary at Milbank.[3] One part of common salt was intimately mixed with one part of the black or binoxide of manganese, then placed in a shallow earthen pan, and two parts of oil of vitriol, previously diluted with two parts by measure of water, poured over it, and the whole stirred with a stick. Chlorine continued to be liberated from this mixture for four days. The quantities of the ingredients consumed were 700 lbs. of common salt, 700 lbs. of binoxide of manganese, and 1400 lbs. of sulphuric acid. The disinfecting power of chlorine is supposed to depend on its affinity for hydrogen, by which it effects the decomposition of water or aqueous vapour, with the hydrogen of which it unites, while the nascent oxygen oxidises the organic matter; or it may act merely by abstracting hydrogen from the putrid miasmata.

Chlorine fumigations are apparently useless in preventing the progress of cholera and erysipelas. In Moscow, chlorine was extensively tried and found unavailing, nay, apparently injurious, in cholera. "At the time," says Dr. Albers,[4] "that the cholera hospital was filled with clouds of chlorine, then it was that the greatest number of the attendants were attacked."[5] Some years ago chlorine was tried at the Small-Pox Hospital, with a view of arresting the progress of erysipelas: all offensive smell, as usual, was overcome, but the power of communicating the disease remained behind.[6]

---

[1] *British and Foreign Medical Review*, vol. iv. p. 212.

[2] *An Experimental Essay on the relative Physiological and Medicinal Properties of Iodine and its Compounds*, by C. Cogswell, A.B. M.D. Edinb. 1837, p. 82.

[3] *Quarterly Journal of Science and of the Arts*, vol. xviii. p. 92.

[4] *London Medical Gazette*, vol. viii. p. 410.

[5] See also Dierbach, *Die neuest. Entd. in d. Mat. Med.* i. 411, 2te Ausg. 1837.

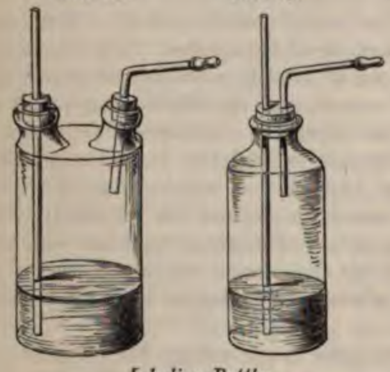
[6] *London Medical Gazette*, viii. 472.

β. *As an antidote in poisoning by hydrocyanic acid, sulphuretted hydrogen, or hydrosulphate of ammonia,* chlorine gas is a very valuable agent. I believe, however, that chloride of lime will be found a more convenient, safe, and opportune substance. The beneficial influence of chlorine in the treatment of animals asphyxiated by sulphuretted hydrogen, doubtless arises, in part at least, from its chemical properties; for when mixed with sulphuretted hydrogen it forms chloride of sulphur and hydrochloric acid. The best method of applying the remedy is to diffuse a little chlorine in the air and then to effect artificial respiration (see *ante,* p. 165).

γ. *Inhaled in chronic pulmonary diseases.*—I have carefully watched its effects in phthisis and chronic bronchitis; and the result of my observation is, that chlorine is rarely serviceable. Frequently, after the first and second inhalations, the patients fancy their breathing much relieved, but the amendment is seldom permanent. I need hardly say it has no pretensions to the cure of tubercular phthisis, but it may be useful as a palliative (sometimes diminishing the sweating); and I can readily believe that occasionally in ulceration of the lungs it may be, as Albers[1] declares it is, of essential service, though I have not found it so. This would agree with effects observed, in surgical practice, of solutions of chlorine and of the hypochlorites on old ulcers.

For inhalation, either the aqueous solution of chlorine, or a small portion of the chloride of lime, may be placed in the inhaling bottles (figs. 66 and 67): if the latter be not sufficiently strong, a few drops of muriatic acid are to be added to develope free chlorine.

FIG. 66. FIG. 67.



Inhaling Bottles.

δ. *In diseases of the liver,* not attended with active inflammation, Mr. Wallace has successfully employed gaseous chlorine, either in the pure state or diluted with air or aqueous vapour. The benefit of chlorine in these cases has been confirmed by others. The temperature of the bath, and the time the patient ought to remain in it, will vary in different instances; but Mr. Wallace thinks that in the greater number 150° F. will be found to answer best, and the proper time about half an hour. The benefit obtained is in part referable to the heat employed; in part to the irritant effect of the chlorine on the skin; and (according to Mr. Wallace) in part to the specific influence of chlorine on the liver.[2] Ziese, an apothecary at Altona, has also employed chlorine baths in these cases with advantage.

ANTIDOTES.—The inhalation of ammoniacal gas, of the vapour of warm water, of spirit of wine, or of ether, has been recommended to relieve the effects of chlorine. I tried them all when suffering myself, but without the least apparent benefit. In a case related by Kastner, and which is reported in Wibmer's work,[1] sulphuretted hydrogen gave great relief. If this agent be employed, it must be done cautiously, as it is itself a powerful poison.

---

[1] *British and Foreign Medical Review,* vol. iv. p. 212.

[2] For a sketch of the apparatus used, see *Lancet,* vol. i. for 1831–32, p. 859.

AQUA CHLORINII, Ph. Dub.; *Chlorinei Aqua*, Ph. Ed.; *Chlorine Water; Solutio Chlorinii; Aqua Oxymuriatica; Liquor Chlori; Liquid Oxymuriatic Acid.*—This is readily prepared by passing chlorine gas (prepared as before directed) through water placed in a Woulfe's bottle. The gas may be generated in a clean Florence flask, to which a curved tube is adapted by means of a cork. The receiving vessel holding the water may be, in the absence of a double-necked bottle, a six- or eight-ounce phial; or a wide-mouthed bottle closed by a cork having two perforations, through one of which passes a glass tube open at the top, and dipping into the water beneath; while through the other passes the end of the tube conveying the gas from the flask into the water.

In the *Dublin Pharmacopœia*, the proportions of ingredients used are, Oxide of Manganese, in fine powder, ℥ss.; Muriatic Acid of commerce, f℥iij.; Distilled Water, ℥xxiv. The oxide is mixed with the acid and with f℥ij. of the water. The chlorine evolved is first passed through an intermediate bottle, containing ℥ij. more of the water, and then passes for solution into a vessel containing the remaining ℥xx. of water. This last vessel must be a three-pint bottle, and when the whole of the air above the water has been displaced by chlorine, agitation is to be had recourse to in order to effect solution.

In the *Edinburgh Pharmacopœia*, the process is somewhat different. Muriate of Soda, 60 grs., and Red Oxide of Lead, 350 grs., are to be triturated together; then put into f℥viij. of Water, contained in a bottle with a glass stopper; afterwards fʒij. of Sulphuric Acid added, and the mixture agitated until all the Red Oxide becomes white. The insoluble matter is to be allowed to subside before using the liquid.

In this process, chlorine and sulphate of soda are formed in solution, and white sulphate of the protoxide of lead is precipitated. The sodium of the common salt is oxidised by the nascent oxygen evolved by the red lead, in consequence of the action of the sulphuric acid on it. This process has been contrived to obviate the necessity of having to pass the gas through water, the apparatus for which operation might not be at hand.

In the Appendix to the London Pharmacopœia, chlorine water is ordered to be prepared from oxide of manganese and hydrochloric acid, but is placed among the tests, and not among the medicines.

In the *Pharmacopœia Nosocomii Middlesexensis*, Lond. 1841, is the following formula for a solution of chlorine (*solutio chlorinii*):—

℞ Potassæ Chloratis, ʒij.; Acidi Hydrochlorici, Aquæ destillatæ, aa. f℥ij. Misce.

When hydrochloric acid in excess is made to act on chlorate of potash, the products are chloride of potassium, water, and free chlorine, $KO,ClO^5 + 6HCl = KCl + 6HO + 6Cl$. The solution, as thus prepared, contains chloride of potassium as well as chlorine. It should be kept in a stoppered bottle in a dark place. It is used in the preparation of a mixture and gargle of chlorine.

1. *Mistura Chlorinii.* ℞ Solutionis Chlorinii, Ph. Middlesex. ℥iij.; Aquæ destillatæ, f℥xij. Misce.—This mixture may be flavoured with simple syrup or syrup of orangepeel. Dose, one or two table spoonfuls.
2. *Gargarisma Chlorinii.* ℞ Solutionis Chlorinii, Ph. Middlesex. f℥ij. Aquæ destillatæ, ℥x. Misce.—Used in scarlet fever, malignant sore-throat, &c.

Chlorine combines with water to form a solid crystalline *hydrate*, $10HO,Cl$. This is pale yellow and transparent. When chlorine gas is prepared over water nearly at the freezing point (32° F.), bubbles of gas, in their passage through the water, sometimes become enveloped with a crystalline coating of the hydrate of chlorine.

---

[1] *Die Wirkung der Arzneim. u. Gifte*, 2er Bd. S. 109, München, 1832.

At the temperature of 60° F., and when the mercury in the barometer is standing at 30 inches, water takes up about twice its bulk of chlorine gas (Gay-Lussac). The solution has a greenish-yellow colour, the strong and peculiar odour of the gas, and an astringent taste. Its sp. gr. is 1·003. At about 32° it freezes and separates into the solid hydrate of chlorine ($10HO,Cl$) and ice free from chlorine. It bleaches vegetable colours, as tincture of litmus, turmeric, &c. By exposure to light, the water is decomposed, oxygen is evolved, and hydrochloric acid formed in solution, $HO+Cl=O+HCl$. Hence the solution should be kept in bottles excluded from the light. Prepared according to the Edinburgh Pharmacopœia, the liquid holds in solution a little sulphate of soda, and deposits a white insoluble sulphate of lead.

Its odour, its action on a solution of nitrate of silver (as before described for chlorine gas), its power of dissolving leaf-gold, and its bleaching properties, readily distinguish this solution. It destroys the blue colour of iodide of starch and of sulphate of indigo. A piece of silver plunged into it is immediately blackened.

In a concentrated form, the aqueous solution of chlorine acts as a corrosive poison. Somewhat diluted, it ceases to be a caustic, but is a powerful local irritant. Administered in proper doses, and sufficiently diluted, it operates as a tonic and stimulant. The continued use of it is said to cause salivation. Applied to dead organic matter, it operates as an antiseptic and disinfectant.

Chlorine water has been employed in medicine both as an external and internal remedy.

Externally it has been used, in the concentrated form, as a caustic application to wounds caused by rabid animals; diluted, it has been employed as a wash in skin diseases (itch and porrigo); as a gargle in putrid sore-throat; as a local bath in liver diseases; and as an application to cancerous and other ulcers attended with a fetid discharge. In the latter cases I have repeatedly employed it with advantage, though I give the preference to a solution of the chloride [hypochlorite] of soda.

Internally it has been administered in those diseases denominated putrid; for example, in the worst forms of typhus, in scarlet fever,[1] and in malignant sore-throat. It has also been employed in venereal maladies, and in diseases of the liver.

[Chlorine has also been used lately in France as an antidote in poisoning by strychnine. M. Bardet states that out of 20 dogs poisoned by nux vomica, he recovered 16 by administering chlorine in solution. He continued the treatment, however, by alternating the chlorine with doses of tartar emetic, so as to cause vomiting before the second dose of chlorine is administered. These cures may possibly have depended entirely on the emetic action of the tartrate; at any rate, the history does not satisfactorily establish the value of the antidote.[2]

The dose of the solution of chlorine varies with the degree of concentration.

---

[1] See a paper *On the Use of Chlorine in Scarlatina*, by Messrs. Taynton and Williams, in *Lond. Med. Gaz.* vol. iv. p. 432. [The authors speak of "the chlorine." Is not a chloride (hypochlorite) meant?]

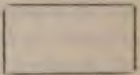
[2] [*Annuaire de Thérapeutique*, par Bouchardat, 1853, p. 83.—Ed.]

I have frequently allowed patients to drink *ad libitum* water to which some of this solution has been added. If made according to the directions of the Dublin Pharmacopœia, the dose is from one to two drachms properly diluted.

According to Devergie,[1] the antidote for poisoning by a solution of chlorine is albumen. The white of egg, mixed with water or milk (the caseum of which is as effective as the albumen of the egg), is to be given in large quantities. The compound which albumen forms with chlorine has little or no action on the animal economy, and may be readily expelled from the stomach. In the absence of eggs or milk, flour might be exhibited; or if this cannot be procured, magnesia or chalk. The gastro-enteritic symptoms are, of course, to be combated in the usual way.

16. ACIDUM HYDROCHLORICUM.—HYDROCHLORIC ACID.

Formula HCl. *Equiv. Weight* 36·5. *Equiv. Volume of the Acid Gas* 2 or



History.—Watery hydrochloric acid was probably known by Geber, the Arabian chemist, in the 8th century. Basil Valentine described it in the 15th century. The present mode of obtaining it was contrived by Glauber. Priestley, in 1774, first obtained gaseous hydrochloric acid. Scheele, in 1774, may be regarded as the first person who entertained a correct notion of the composition of this acid; and to Sir H. Davy we are principally indebted for the establishment of Scheele's opinion.

The acid was formerly called *marine* or *muriatic acid* (from *muria*, brine or salt water). It is now usually termed, from its composition, *hydrochloric* or *chlorhydric acid*.

Natural History.—It is found in both kingdoms of nature.

α. In the Inorganised Kingdom.—Hydrochloric acid is one of the gaseous products of volcanoes.

β. In the Organised Kingdom.—Free hydrochloric acid is a constituent of the gastric juice in the human subject (?). Chevreul states that he detected free hydrochloric acid in the juice of *Isatis tinctoria*.

Forms.—Hydrochloric acid is used in two forms; in the gaseous state (*gaseous hydrochloric acid*), and dissolved in water (*watery hydrochloric acid*).

1. Gaseous Hydrochloric Acid.

Synonymes.—*Muriatic acid gas; hydrochloric acid gas; chlorhydric acid gas.*

Preparation.—Hydrochloric acid, in the gaseous state, is procured by the action of oil of vitriol on dried chloride of sodium. The ingredients should be introduced into a tubulated retort, the neck of which is lined with bibulous paper, and the gas collected over mercury. Or they may be placed in a clean and dry oil flask, and the gas conveyed, by means of a glass tube curved twice at right angles, into a proper receptacle, as a bottle, from which the gas expels the air by its greater gravity.

---

[1] *Médecine Légale*, t. ii. p. 634, Paris, 1836.

In this process, one equivalent of chloride of sodium reacts on one equivalent of protohydrate of sulphuric acid (strong oil of vitriol), and produces one equivalent of hydrochloric acid (gas), and one equivalent of sulphate of soda. $NaCl + HO,SO^3 = NaO,SO^3 + HCl$.

Materials.		Composition.			Products.	
1 eq. Chloride Sodium	58·5	1 eq. *Chlorine*	35·5		1 eq. Hydrochloric Acid	36·5
		1 eq. *Sodium*	23			
1 eq. Liquid Sulphuric Acid.	49	1 eq. *Water* 9 { 1 *Hydrog.*	1			
		1 *Oxygen*	8	1 eq. *Soda* 31		
		1 eq. *Sulphuric Acid* ..	40		1 eq. Sulph. Soda	71
	107·5		107·5			107·5

Properties.—It is a colourless invisible gas, fuming in the air, in consequence of its affinity for aqueous vapour. It is rapidly absorbed by water. At 40° F., water dissolves about 480 times its bulk of this gas. Its specific gravity is 1·264 [1·269, Berzelius]. It has a pungent odour and acid taste. Under a pressure of 40 atmospheres, at 40° F., it becomes a colourless liquid (*liquid hydrochloric acid*). It is neither combustible nor a supporter of combustion. When added to a base (that is, a metallic oxide), water and a chloride are the results. $HCl + MO = HO + MCl$.

Characteristics.—Hydrochloric acid gas is known by its fuming in the air, by its odour, by its reddening moistened litmus paper, by its forming white fumes with the vapour of ammonia, and by its yielding, with a solution of nitrate of silver, a white precipitate of chloride of silver (see *ante*, p. 381).

Composition.—The composition of this gas is determined both by analysis and synthesis. Thus, one volume of chlorine gas may be made to combine with one volume of hydrogen gas by the aid of light, heat, or electricity; and the resulting compound consists of two volumes of hydrochloric acid gas. Potassium or zinc heated in two volumes of this acid gas, absorbs the chlorine and leaves a volume of hydrogen.

Constituents.		*Results.*
1 eq. Chlor. =35·5.	=	1 eq. Hydrochloric acid gas = 36·5
1 eq. Hydr. = 1.		

	Atoms.	*Eq. Wt.*	*Per Ct.*
Chlorine ...	1 ...	35·5 ...	$97{\cdot}3\dot{3}$
Hydrogen ...	1 ...	1 ...	$2{\cdot}6\dot{6}$
Hydrochloric Acid	1 ...	36·5 ...	100·000

	Vol.	*Sp. Gr.*
Chlorine gas	1 ...	2·46
Hydrogen gas	1 ...	0·069
Hydrochloric Acid Gas..............	1 ...	1·264

Physiological Effects. α. *On Vegetables.*—Mixed with 20,000 times its volume of atmospheric air, this gas is said, by Drs. Christison and Turner,[1] to have proved fatal to plants, shrivelling and killing all the leaves in twenty-four hours. But according to Messrs. Rogerson,[2] it is not injurious to vegetables when mixed with 1500 times its volume of air. Dr. Christison ascribes these different results to Messrs. Rogerson having employed jars of too small size. We have good evidence of the poisonous operation of this gas on vegetables in the neighbourhood of those chemical manufactories in which carbonate of soda is procured from common salt. The fumes of the acid which issue from these works have proved so destructive to the surrounding vegetation, that, in some instances, the proprietors have subjected themselves to actions at law, and have been compelled either to pay damages, or to purchase the land in their immediate vicinity.

---

[1] Christison's *Treatise on Poisons.*

[2] *London Medical Gazette*, vol. x. p. 312.

β. *On Animals* this gas acts injuriously, even when mixed with 1500 times its volume of atmospheric air. Mice or birds introduced into the pure gas, struggle, gasp, and die, within two or three minutes. Diluted with atmospheric air, the effects are of course milder, and in a ratio to the quantity of air present. In horses it excites cough and difficulty of breathing. When animals are confined in the dilute gas, in addition to the laborious and quickened respiration, convulsions occur before death. Messrs. Rogerson state, that "in a legal suit for a general nuisance, tried at the Kirkdale Sessions House, Liverpool, it was proved that horses, cattle, and men, in passing an alkali-works, were made, by inhaling this gas, to cough, and to have their breathing much affected. In the case of Whitehouse *v.* Stevenson, for a special nuisance, lately tried at the Staffordshire Assizes, it was proved that the muriatic acid gas from a soap manufactory destroyed vegetation, and that passengers were seized with a violent sneezing, coughing, and occasional vomiting. One witness stated, that when he was driving a plough, and saw the fog, he was obliged to let the horses loose, when they would gallop away till they got clear of it." It acts as an irritant on all the mucous membranes.

γ. *On Man* this gas acts as an irritant poison, causing difficult respiration, cough, and sense of suffocation. In Mr. Rogerson's case, it caused also swelling and inflammation of the throat. Both in man and animals it has appeared to produce sleep.

The action of hydrochloric acid gas on the lungs is injurious in at least two ways: by excluding atmospheric air, it prevents the decarbonisation of the blood; and, secondly, by its irritant, and perhaps also by its chemical properties, it alters the physical condition of the bronchial membrane. The first effect of attempting to inspire the pure gas seems to be a spasmodic closure of the glottis (see *ante*, p. 117). Applied to the conjunctiva, it causes irritation and opacity.

USE.—It has been employed as a *disinfectant* (see *ante*, p. 166), but is admitted on all hands to be much inferior to chlorine. The Messrs. Rogerson deny that it possesses any disinfecting property. It is perhaps equally difficult either to prove or disprove its powers in this respect. The experiments of Guyton-Morveau, in purifying the cathedral of Dijon, in 1773, are usually referred to in proof of its disinfecting property. If it possess powers of this kind, they are certainly inferior to chlorine, or the chlorides [hypochlorites] of lime or soda; but, in the absence of these, hydrochloric acid gas may be tried. In neutralising the vapour of ammonia it is certainly powerful.

APPLICATION.—In order to fumigate a room, building, or vessel, with this gas, pour some strong oil of vitriol over dried common salt, contained in a saucer or iron or earthen pot, heated by a charcoal fire or hot sand. The saucers should be placed in the higher parts of the chamber, so that the gas may descend by its gravity.

ANTIDOTE.—Inhaling the vapour of ammonia may be serviceable in neutralising hydrochloric acid gas. Symptoms of bronchial inflammation are of course to be treated in the usual way.

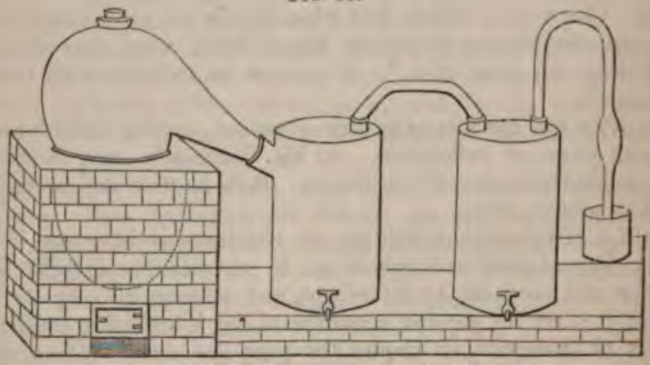
2. Watery Hydrochloric Acid.

SYNONYMES.—This watery or liquid acid was formerly called *spirit of salt* (*spiritus salis*), or *spirit of sea salt* (*spiritus salis marini*), or *Glauber's spirit of salt* (*spiritus salis marini Glauberi*).

It is now commonly termed *muriatic acid* (*acidum muriaticum*, Ph. Ed. and Dub.) or *hydrochloric acid* (*acidum hydrochloricum*, Ph. Lond.); or sometimes *chlorhydric acid*.

PREPARATION.—This is obtained by submitting a mixture of common salt (chloride of sodium) and oil of vitriol to distillation in a proper apparatus, and condensing the hydrochloric acid gas which passes over in water contained in the receiver. Manufacturers of hydrochloric acid generally employ an iron or stoneware pot set in brickwork over a fire-place, with a stoneware head luted to it, and connected with a row of double-necked bottles, made of the same material, and furnished with stop-cocks of earthenware. The last bottle is supplied with a safety tube, dipping into a vessel of water (fig. 68).

FIG. 68.



Apparatus for making Hydrochloric Acid.

The liquid obtained by this process is yellow, and constitutes *commercial muriatic acid* (*acidum muriaticum venale; hydrochloric acid of commerce*, Ph. Ed.)

Since the manufacture of carbonate of soda from the sulphate of soda, and the consequent necessity of obtaining the latter salt in large quantities, another mode of making hydrochloric acid has been sometimes adopted. It consists in using a semi-cylindrical vessel for the retort: the upper or flat surface of which is made of stone, while the curved portion exposed to the fire is formed of iron. The chloride of sodium is introduced at one end, which is then closed by an iron plate, perforated to allow the introduction of the leg of a curved leaden funnel, through which strong sulphuric acid is poured. The funnel is then removed, and the aperture closed. Heat being applied, the hydrochloric acid gas is developed, and is conveyed by a pipe into a double-necked stoneware bottle, half filled with water, and connected with a row of similar bottles likewise containing water.

The Edinburgh and Dublin Pharmacopœias give directions for making hydrochloric acid. The *London College* gives no formula, but places it in the Materia Medica with a note appended to ascertain its purity. The *Edinburgh College* directs the common salt to be previously purified

"by dissolving it in boiling water; concentrating the solution; skimming off the crystals as they form on the surface; draining from them the adhering solution as much as possible;

and subsequently washing them with cold water slightly." It employs equal weights of Common Salt, purified by recrystallisation, subsequently washing them with cold water, and then drying them; Pure Sulphuric Acid; and Water.

The *Dublin College* orders of Dried Muriate of Soda, lb. iij.; Sulphuric Acid of commerce, f℥xliv.; Water, f℥xxxij.; and Distilled Water, f℥xliv.

The Chloride of Sodium is to be introduced into a glass retort, and the Sulphuric Acid mixed with one-third part, *E.* [℥xxxij. *D.*] of the Water [and allowed to cool, *E.*] is then poured over the Salt; the remainder of the water being placed in the receiver. Distillation is then to be effected [by a naked gas-flame, *E.*] so that the gas may pass over into the water contained in the receiver [which is to be kept cool by snow, or a stream of cold water, *E.*] The Acid thus procured is called, by the Edinburgh College, *Acidum muriaticum purum.*

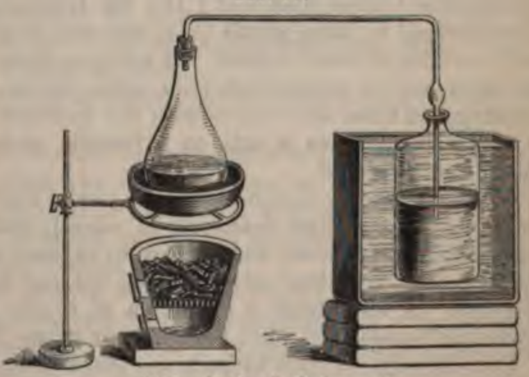
The *theory* of the above process is precisely that already explained in the manufacture of hydrochloric acid gas (see *ante*, p. 388). The salt is dried, to expel any water which may be mechanically lodged between the plates of the crystal, and to obtain uniform weights. Common salt frequently or usually contains traces of nitrate of soda; and in consequence yields, by distillation with sulphuric acid, hydrochloric acid contaminated with chlorine. To get rid of the nitrate, the chloride should either be exposed to a full red heat before it is placed in the still, or purified by recrystallisation and washing, as recommended by the Edinburgh College.

Unless care be taken to use pure sulphuric acid, the resulting watery hydrochloric acid will be contaminated with various impurities derived from the oil of vitriol (see pp. 367 and 368).

Dr. Gregory[1] gives the following directions for preparing pure liquid hydrochloric acid:—

"6 parts by weight of pure salt are introduced into a flask or matrass, and covered with 10 parts by weight of oil of vitriol, and 4 parts of water, the latter having been previously mixed, and the mixture allowed to cool: or we may take 8·5 parts of sulphuric acid sp. gr. 1·65. No action takes place in the cold, so that we may adapt securely a bent tube to convey the gas to the flask (fig. 69). This tube is twice bent at right angles, and has a bulb blown on the longer descending limb. In a bottle surrounded with ice-cold water is placed a quantity of distilled water equal in weight to the salt, and the bent tube is made to dip about an eighth of an inch into this water. A gentle heat is now applied to the flask, which rests in a sand-pot, and continued as long as any hydrochloric acid comes over. In about two hours the process is finished, and we find the distilled water increased in volume nearly two thirds, and converted into hydrochloric acid, quite pure and colourless, of sp. gr. 1·14 to 1·15. If we wish it as strong as possible, or of sp. gr. 1·21, we have only to employ, in a second operation, a part of the acid above described in the place of the distilled water, during the first half of the operation, when it will speedily become saturated. No

FIG. 69.



Hydrochloric Acid Apparatus.

---

[1] *Outlines of Chemistry*, Part i. p. 72, 1845.

safety tube is required; it is only necessary to lower the bottle a little occasionally, so that the tube shall never dip far into the liquid; and even should absorption take place too rapidly, and the water rise in the tube, the bulb will receive it, the end of the tube will be exposed, and air entering will prevent the regurgitation of water into the flask. This simple tube, therefore, forms a self-acting valve, and renders a safety tube unnecessary. The absorbing liquid must be kept as cold as possible, by frequently changing the surrounding water, which becomes warm owing to the heat developed in the absorption. If ice can be had, a little added to the cooling vessel from time to time keeps the temperature sufficiently low.

"In the above operation, the proportions of acid and salt are according to the formula $NaCl + 2(HO,SO^3) = (NaO,HO,2SO^3) + HCl$. Here, 2 eq. of acid are employed for one of salt, for two reasons: 1st, a much lower heat is required; and 2dly, the resulting salt, bisulphate of soda, is quite easily got out without risking the flask, which is not the case when 1 eq. of acid is used, and neutral sulphate is left. The acid is diluted to sp. gr. 1·65, or even 1·60, for the same reasons. The addition of the water facilitates the operation, and renders the resulting mass more soluble and manageable. It is to be observed that, notwithstanding this addition of water, two-thirds of the hydrochloric acid gas come off quite dry, and it is only towards the end of the operation that, the heat being increased, water and acid come off together. This is easily known by the tube becoming hot from the condensation of the steam. From first to last not a trace of sulphuric acid passes over, even into the tube; and thus, by using tolerably pure materials, we obtain colourless and pure hydrochloric acid as easily and cheaply as if we were making the very impure acid of commerce. By the above process, the purest and strongest hydrochloric acid might be sold for not more than 3d. per lb., probably for less."

The quantity of strong sulphuric acid (HO,SO^3) required to saturate 2 lbs. of common salt is $19\frac{6}{10}$ oz.; so that the Edinburgh College directs a great excess.

In commerce, a liquid called pure muriatic acid is obtained in the manufacture of *spirit of tin*. Tin is dissolved in commercial muriatic acid, and the solution submitted to heat in green glass retorts: muriatic acid distils over, and the residue in the retort constitutes spirit of tin.

Properties.—Pure watery or liquid hydrochloric acid (*acidum hydrochloricum purum*) is colourless, evolves acid fumes in the air, and possesses the usual characteristics of a strong acid. It has the odour and taste of the gaseous acid. Its specific gravity varies with its degree of concentration. The London College fixes it at 1·16; the Edinburgh College at 1·170. It is decomposed by some metals (*e. g.* zinc and iron), hydrogen being evolved, and a metallic chloride formed. It reacts on those oxyacids which contain five equivalents of oxygen each (*e. g.* nitric, chloric, iodic, and bromic acids): the oxygen of these acids unites with the hydrogen of the hydrochloric acid to form water. When it acts on a metallic oxide, water and a metallic chloride are produced.

Characteristics.—Hydrochloric acid yields, with nitrate of silver, a white, clotty, fusible precipitate (*chloride of silver*), which is insoluble in nitric acid, soluble in ammonia, and blackens by exposure to light (see *ante*, p. 381). When pure, it is without action on gold leaf, and does not decolorise sulphate of indigo. A rod dipped in a solution of caustic ammonia produces white fumes (*sal ammoniac*) when brought near strong liquid hydrochloric acid.

Composition.—Liquid hydrochloric acid is composed of *water* holding in solution *hydrochloric acid gas*. When its sp. gr. is 1·162, its composition, according to Dr. Thomson,[1] is as follows:—

---

[1] *An Attempt to establish the First Principles of Chemistry*, vol. i. p. 87, Lond. 1825.

	Atoms.	*Eq. Wt.*	*Thomson.*
Hydrochloric acid gas	1	37	33·95
Water	8	72	66·05
Liquid Hydrochloric Acid, sp. gr. 1·162	1	109	100·00

In the London Pharmacopœia, it is stated that 132 grains of crystallised carbonate of soda saturate 100 grains of acid, sp. gr. 1·16. This would indicate a per-centage strength of 33·916.

DR. THOMSON'S TABLE, EXHIBITING THE SPECIFIC GRAVITY OF HYDROCHLORIC ACID OF DETERMINATE STRENGTHS.

Atoms of Water to one of Acid.	*Real Acid in 100 of the Liquid.*	*Specific Gravity.*	*Atoms of Water to one of Acid.*	*Real Acid in 100 of the Liquid.*	*Specific Gravity.*
6	40·659	1·203	14	22·700	1·1060
7	37·900	1·179	15	21·512	1·1008
8	33·945	1·162	16	20·442	1·0960
9	31·346	1·149	17	19·474	1·0902
10	29·134	1·139	18	18·590	1·0860
11	27·206	1·1285	19	17·790	1·0820
12	25·517	1·1197	20	17·051	1·0780
13	24·026	1·1127			

IMPURITIES.—Commercial hydrochloric acid is always more or less impure. The substances with which it has been found to be contaminated are *sulphuric acid, sulphurous acid, nitrous acid, chlorine, chloride of arsenic,* and *sesquichloride of iron.*

1. *Sulphuric acid* (free or combined) may be detected by adding to the suspected acid a solution of chloride of barium (or nitrate of baryta): if sulphuric acid be present, a heavy white precipitate of sulphate of baryta is procured, which is insoluble in nitric acid. In applying this test, the suspected acid should be previously diluted with five or six times its volume of water; otherwise a fallacy may arise from the crystallisation of the chloride of barium.

2. *Sulphurous acid* (formed by the action of sulphuric acid on the iron pot) is detected by protochloride of tin, which, after some time, yields a yellow, then a brown precipitate of sulphuret of tin.

3. *Nitrous acid* is detected by pure oil of vitriol and sulphate of iron (see *ante*, p. 368).

4. *Chlorine* gives a yellow colour to hydrochloric acid. It may be detected by its odour, by its enabling the liquid to dissolve leaf-gold, and by its decolorising a solution of sulphate of indigo.—A solution of protochloride of tin is the readiest test for detecting any gold which may be dissolved, with which it forms a purplish or blackish precipitate.

5. The presence of *iron* (derived from the iron pot) is shown by saturating the acid with carbonate of soda, and then applying tincture of nutgalls, which produces a black tint. Another mode is to supersaturate the liquid with ammonia or its sesquicarbonate, by which the red or sesquioxide of iron will be precipitated.

6. *Arsenic* has been occasionally found in hydrochloric acid. It is derived from the employment of arsenical oil of vitriol (see *ante*, p 368) in its manufacture; and is doubtless in the state of chloride of arsenic. It may be

detected by Marsh's test, or by diluting the acid and transmitting sulphuretted hydrogen through it, by which orpiment (AsS^3) is precipitated.

7. *Fixed impurities* are found in the residue after the distillation of the acid.

8. The *strength* of the acid is determined by its sp. gr. and its saturating power.

The following are the characters of pure hydrochloric acid as given by the London College, in the note appended by them in the Materia Medica :—

> Colourless; specific gravity, 1·16; exposed to air it emits white acrid vapours; entirely dissipated by heat. Mixed with water it produces no precipitate on the addition either of chloride of barium, of ammonia, or of the sesquicarbonate of ammonia. It exerts no action upon gold leaves, even when boiled with them, nor is anything thrown down if protochloride of tin be afterwards added. It does not decolorise a solution of sulphate of indigo. 100 grains of this acid are saturated by 132 grains of crystals of carbonate of soda.

To the above should be added, that sulphuretted hydrogen being transmitted through it produces no yellow or brownish colour. The Edinburgh College fixes the density at 1·180.

PHYSIOLOGICAL EFFECTS. *a. On Dead Animal Matter.*—Very dilute hydrochloric acid, mixed with dried mucous membrane, has the property of dissolving various animal substances (as coagulated albumen, fibrin of the blood, boiled meat, &c.), and of effecting a kind of artificial digestion of them, somewhat analogous to the natural digestive process.[1]

β. On Animals.—The effects of liquid hydrochloric acid on living animals (horses and dogs) have been investigated by Sproegel, Courton, Viborg,[2] and by Orfila.[3] Thrown into the veins, it coagulates the blood and causes speedy death. Small quantities, however, may be injected without giving rise to fatal results. Thus Viborg found that a horse recovered in three hours from the effects of a drachm of this acid, diluted with two ounces of water, thrown into a vein. Administered by the stomach to dogs, the undiluted acid acts as a powerful caustic poison. Exhalations of the acid vapours take place through the mouth and nostrils, and death is generally preceded by violent convulsions.

γ. On Man.—Properly diluted, and administered *in small but repeated doses*, hydrochloric acid produces the usual effects of a mineral acid before described (pp. 97 and 174). It usually causes a sensation of warmth in the stomach, relaxes the bowels, and increases the frequency of the pulse. *Larger doses* are said to have excited giddiness and a slight degree of intoxication or stupor. In a *concentrated form* it operates as a powerfully caustic poison. The only recorded cases of poisoning by it (in the human subject) with which I am acquainted, are one mentioned by Orfila[4] and another related by my friend and former pupil, Mr John Quekett.[5] In the latter case the stomach and duodenum were found, after death, to be charred, and the gall-bladder was observed to have a green tint at the part where it was in contact with the stomach [from the action of the acid on the bile?]. It is remarkable that the contents of the stomach manifested no acidity to litmus; nor could any chloride be recognised by nitrate of silver, either in the decoction of the stomach and duodenum or in the contents of the stomach. The particular nature of the chemical changes effected by it in the organic tissues with which it comes in contact, is not so well understood as in the case of sulphuric or nitric acid. Its chemical action is less energetic than either nitric or sulphuric acid.

---

[1] Müller, *Elements of Physiology*, p. 544.
[2] Wibmer, *Die Wirkung der Arzneimittel und Gifte.*
[3] *Toxicologie Générale.*
[4] *Ibid.*
[5] *London Medical Gazette*, vol. xxv. p. 285, Nov. 15, 1839.

USES. *a. Internal* or *Remote.*—Hydrochloric acid has been employed in those diseases formerly supposed to be connected with a putrescent condition of the fluids; as the so-called putrid and petechial fevers, malignant scarlatina, and ulcerated sore-throat. It is usually administered in these cases in conjunction with the vegetable tonics; as cinchona or quassia. It is frequently employed to counteract phosphatic deposits in the urine (see *ante*, pp. 177 and 178). After a copious evacuation, it is, according to Dr. Paris, the most efficacious remedy for preventing the generation of worms; for which purpose the infusion of quassia, stronger than that of the Pharmacopœia, is the best vehicle. It has been employed with benefit in some forms of dyspepsia. Two facts give a remarkable interest to the employment of this acid in dyspeptic complaints—namely, that it is a constituent of the healthy gastric juice;[1] and secondly, when mixed with mucus, it has a solvent or digestive power in the case of various articles of food, as before mentioned. Lastly, hydrochloric acid has been used in scrofulous and venereal affections,[2] in hepatic disorders, &c.

β. External.—In the concentrated form it is employed as a caustic to destroy warts, and as an application in sloughing phagedæna, though for the latter purpose it is inferior to nitric acid. Van Swieten[3] employed it in cancrum oris; and more recently Bretonneau[4] has spoken in the highest terms of its efficacy in angina membranacea, commonly termed diphtheritis. It is applied to the throat by a sponge. Properly diluted, it forms a serviceable gargle in ulceration of the mouth and throat. The objection to its use as a gargle is its powerful action on the teeth: to obviate this as much as possible, the mouth is to be carefully rinsed each time after using the gargle. It is sometimes applied to ulcers of the throat by means of a sponge. Water acidulated with this acid has been applied to frost-bitten parts, to chilblains, &c. An injection composed of from eight to twelve drops of the acid to three or four ounces of water, has been employed as an injection in gonorrhœa.

ADMINISTRATION.—It is given, properly diluted, in doses of from five to fifteen or twenty minims.

ANTIDOTES.—In a case of poisoning by hydrochloric acid, the antidotes (see *ante*, p. 164) are chalk, whiting, magnesia or its carbonate, and soap; and in the absence of these, oil, the bicarbonated alkalies, milk, white of egg, or demulcents of any kind. Of course the gastro-enteritis is to be combated in the usual way.

ACIDUM HYDROCHLORICUM DILUTUM, L.; *Acidum Muriaticum dilutum*,

---

[1] It has recently been stated, that the free acids of the gastric juice are the phosphoric and lactic; and that the hydrochloric is derived from the chlorides of sodium and potassium.

[2] *London Medical Review*, vol. ii. p. 278, Lond. 1830.

[3] *Commentaries*, Eng. Transl. vol. iv. p. 31, Edinb. 1776.

[4] *Recherches sur l'Inflammation spéciale du tissu muqueux, et en particulier sur la diphthérite, angine maligne, ou croup épidémique*, Paris, 1826.

E. D.; *Diluted Muriatic Acid.* (Hydrochloric Acid, f℥v. [iv. *E.* and *D.*]; Distilled Water, f℥xv. [xij. *E.* and xiij. *D.*])—The dose is from ℨss. to ℨj. The most agreeable mode of exhibiting it is in the infusion of roses, substituting the hydrochloric for sulphuric acid. The specific gravity of the London acid is 1·043, the Edinburgh, 1·050, and the Dublin, 1·045. One hundred grains of the London acid are saturated by 168 grains of crystals of carbonate of soda.

17. Sulphuris Dichloridum.—Dichloride of Sulphur.

Formula S^2Cl. *Equivalent Weight* 67·5. *Equivalent Volume of the Vapour* 1 or □

Protochloride of sulphur; hypochloride of sulphur; subchloride of sulphur; sulphur chloratum; hypochloretum sulphurosum; bisulphuret of chlorine; chlorum hypersulphuratum.—Discovered by Dr. T. Thomson in 1803. Obtained by transmitting dry chlorine gas over washed and dried flowers of sulphur until these are for the most part dissolved. The decanted fluid is to be distilled by a gentle heat from the excess of dissolved sulphur.

It is a brownish-yellow oily liquid, whose specific gravity is 1·687. It fumes in the air. Its odour is strong, and somewhat like that of sea plants. Its taste is acrid, hot, and bitter. When the eyes are exposed to its vapour, it excites a copious flow of tears, and a painful sensation, like that caused by peat-smoke. When dropped into water, it is gradually converted into hydrochloric acid, sulphur, and hyposulphurous acid; the latter resolving itself into sulphurous acid and sulphur. $2S^2Cl + 2HO = 2HCl + SO^2 + 2S$. It consists of 32 parts of sulphur and 35·5 of chlorine.

Dichloride of sulphur has been employed in medicine both as an external and as an internal remedy. In obstinate lepra and psoriasis, an ointment composed of one drachm of the dichloride to an ounce of lard has been used with great success. Biett also employed it in the form of ointment in skin diseases (Mérat and De Lens). Internally, Derksenyc[1] employed it in obstinate gouty pains with stomach complaints, and also in a dangerous nervous fever. He gave it in doses of ten drops, dissolved in ether, and taken in wine. It deserves, however, to be noticed, that although ether at first dissolves, it gradually decomposes the dichloride.

ORDER VIII. IODINE AND ITS COMBINATIONS WITH OXYGEN, HYDROGEN, SULPHUR, AND CHLORINE.

18. IODINIUM.—IODINE.

Symbol I. *Equivalent Weight* 126. *Equivalent Volume of Iodine Vapour* 1 or □

HISTORY.—Iodine was discovered in 1811 by M. Courtois, a saltpetre manufacturer at Paris. It was first described by Clement in 1813, but was afterwards more fully investigated by Davy and Gay-Lussac. It was named *iodine* (*iodinium*, Ph. L. and D.; *iodineum*, Ph. Ed.; *iodum; iodina*) from ἰώδης, *violet-coloured;* on account of the colour of its vapour.

NATURAL HISTORY.—It exists in both kingdoms of nature.[2]

---

[1] Duflos, *Die Lehre von d. chem. Arzneimitteln*, Breslau, 1842.

[2] Since the publication of the first edition of this work, I have met with S. E. Sarphati's *Commentatio de Iodio*, Lugduni, 1835, in which is found the most extensive list of natural bodies containing iodine, of any work with which I am acquainted.

α. IN THE INORGANISED KINGDOM.—Vauquelin met with iodide of silver in a mineral brought from Mexico; and Mentzel found iodine in an ore of zinc which contained cadmium. It has also been met with in an ore of lead.[1] Del Rio found iodide of mercury in Mexico. Iodine is said to have been found in coals.[2] An alkaline iodide has been detected in the Chili nitrate of soda. In sea water iodine has likewise been discovered, where it probably exists as an iodide of sodium or of magnesium. Many mineral waters contain it. It was detected by Mr. Copeland[3] in the carbonated chalybeate of Bonnington. About one grain of iodine was found by Dr. Daubeny[4] in ten gallons of the water of Robin's Well at Leamington, in Warwickshire. In the old well at Cheltenham, the quantity was not more than one grain in sixty gallons. It is a frequent constituent of brine springs (see *ante*, p. 315). In a brine spring at Nantwich, in Cheshire, there was about a grain of iodine in twelve gallons. In the sulphurous water of Castel Nuovo d' Asti iodine was discovered by Cantu. In some of the mineral waters of Germany, Bavaria, and South America, it has also been detected.[5] Fuchs found it in the rock salt of the Tyrol.[6]

β. IN THE ORGANISED KINGDOM.—Of animals containing iodine I may mention the genera *Spongia*, *Gorgonia*, *Doris*, *Venus*, &c.: likewise *Sepia*, the envelopes of the eggs of which contain it. An insect has been found near Ascoli, in Italy, which Savi has described under the name of *Julus fœtidissimus*, containing iodine. The animal emits, when disturbed, a yellow fluid strongly smelling of iodine, and which immediately strikes the characteristic violet colour with starch.[7] Iodine has been detected in the oil of the cod's liver.[8] A very considerable number of vegetables, particularly those belonging to the family Algæ, yield it. The following are some instances:—*Fucus vesiculosus*, *F. serratus*, and *F. nodosus*; *Laminaria saccharina*, and *L. digitata*; *Halidrys siliquosa*; *Chorda Filum*; *Gelidium cartilagineum*; *Halyseris polypodioides*; *Phyllophora rubens*; *Rhodomenia palmata*; *Ulva Linza*; *Porphyra umbilicalis*; *Padina Pavonia*; *Gigartina Helminthocorton*; and some of the marine *Confervæ*.

"The following table, drawn up by Mr. Whitelaw, a manufacturer in Glasgow, from his own experiments, shows the proportion of iodine contained in some of the most common Algæ on our sea-coasts:—

	Ratios of Iodine.		*Ratios of Iodine.*
Laminaria digitata	100	Fucus serratus	20
Laminaria bulbosa	65	Fucus bulbosus	15
Laminaria saccharina	35		

The quantities of chloride of potassium in those Algæ follow nearly the same ratio."[9] Professor Graham states that, according to Mr. Whitelaw, the long elastic stems of the *Rhodomenia palmata* afford most of the iodine contained in kelp.

Professor Graham[10] has suggested the manufacture of iodine from Guernsey kelp, which being the produce of deep sea fuci, contains more iodine than ordinary kelp.

It has been found in several species of phænogamous plants, as *Zostera marina*; and, more recently, in two growing in Mexico—namely, a species of *Agave*, and one of *Salsola*.[11]

[Iodine has been detected in plants growing in fresh water by M. Adolphus Chatin. Those growing in running water, and in water much disturbed by winds, contain more than plants growing in stagnant pools. M. Chatin failed entirely in detecting iodine in land plants, having examined a considerable number for the purpose. The aquatic plants in which he found it were the water-cress (nasturtium officinale) nasturtium amphibium, conferva crispata, chara fœtida, fontinalis antipyretica, typha augustifolia and minima, scirssus lacustris, arundo phragmites, acorus calamus, sagittaria, potamogeton crispum and pectinatum, veronica beccabunga, phellandrium aquaticum, gratiola, ranunculus flammula. M. Chatin concludes that this iodine comes from every part of the earth, from which, associated with chlorides, it is dissolved out by the flowing of the water. This explains why plants in running streams contain most iodine.[1]—ED.]

---

[1] *Journ. de Pharmacie*, tom. xxiii. for 1837, p. 29.

[2] *Lond. and Edinb. Philosoph. Mag.* for Nov. 1839.

[3] *Edinburgh New Philosophical Journal*, vol. i. p. 159.

[4] *Phil. Trans.* 1830, Part ii. p. 223.

[5] Gairdner, *Essay on the Natural History, Origin, Composition, and Medicinal Effects of Mineral and Thermal Springs*, p. 27, Edinb. 1832.

[6] Gmelin, *Handbuch der Chemie*, Bd. i. S. 350.

[7] Dulk, *Die Preussische Pharmakopöe*, Bd. i. S. 583, Leipzig, 1829; and *British and Foreign Medical Review* for January 1838, p. 163.

[8] *Journ. de Pharmacie*, tom. xxiii. p. 501.

[9] Thomson, *Organic Chemistry*, p. 946.

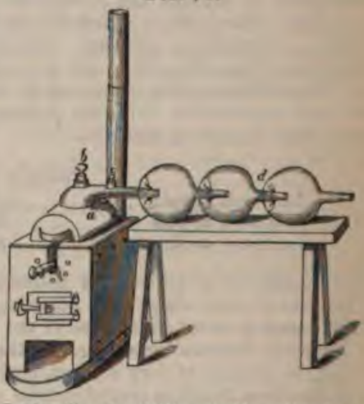
[10] *Mem. and Proceedings of the Chemical Society*, vol. iii. p. 252.

[11] *Journal de Pharmacie*, tom. xxiii. p. 31.

PREPARATION.—British iodine is exclusively manufactured at Glasgow, from the kelp of the west coast of Ireland and the western islands of Scotland.

The kelp is broken into pieces and lixiviated in water, to which it yields about half its weight of salts. The solution is concentrated by evaporation, and thereby deposits soda salts (common salt, carbonate and sulphate of soda), and on cooling also lets fall crystals of chloride of potassium. The mother liquor (called *iodine ley*) is dense, dark-coloured, and contains the iodine, in the form, it is believed, of iodide of sodium. Sulphuric acid is added, to render the liquid sour, by which carbonic acid, sulphuretted hydrogen, and sulphurous acid gases are evolved, and sulphur is deposited. The workmen set fire to the sulphuretted hydrogen as it escapes, to obviate its bad effects. The acid ley is then introduced into a leaden still (fig. 70, *a*), and heated to 140° F., when binoxide of manganese is added. A leaden head having two stoppers (*b* and *c*) is then adapted and luted with pipe-clay, and to the neck of the head is fitted a series of spherical glass condensers (*d*), each having two mouths opposite to each other, and inserted the one into the other. Iodine is evolved, and is collected in the condensers. The process is watched by occasionally removing the stopper *c*, and additions of sulphuric acid or manganese are made by *b*, if deemed necessary.[2]

FIG. 70.



Iodine Leaden Still and Glass Receiver.

The following is the mutual reaction of sulphuric acid, binoxide of manganese, and iodide of sodium:—Two equivalents of sulphuric acid react on one equivalent of binoxide of manganese, and on one equivalent of iodide of sodium; and yield one equivalent of iodine, one equivalent of sulphate of soda, and one equivalent of the sulphate of the protoxide of manganese. $NaI + MnO^2 + 2SO^3 = NaO,SO^3 + MnO, SO^3 + I$.

MATERIALS.		COMPOSITION.			PRODUCTS.	
1 eq. Iodide of Sodium .	149	1 *eq. Iodine*	126		1 eq. Iodine..............	126
		1 *eq. Sodium*	23	1 *eq. Soda* 31		
1 eq. Binoxide Mangan.	44	1 *eq. Oxygen*......	8			
		1 *eq. Protox. Mang.*	36			
2 eq. Sulphuric Acid....	80	1 *eq. Sulph. Acid*..	40		1 eq. Sulphate Soda	71
		1 *eq. Sulph. Acid*..	40		1 eq. Protosulphate Mang.	76
	273		273			273

The evolution of iodine in the preceding process may also be accounted for in another way. By the mutual reaction of sulphuric acid, binoxide of manganese, and a chloride (as of sodium or potassium), chlorine is set free. This reacting on iodide of sodium would liberate iodine, and form chloride of sodium. Or, the hydriodic acid set free from a solution of iodide of sodium by sulphuric acid may be decomposed by the nascent chlorine.

---

[1] *Comptes rendus: Pharmaceutical Transactions*, vol. x. p. 80.

[2] For further details, consult Graham's *Elements of Chemistry*, vol. i. p. 384. See also Dr. Thomson, in the *Athenæum* for 1840, p. 772.

PROPERTIES.—Iodine is a crystallisable solid, its primary form being a rhombic octahedron[1] (see *ante*, p. 145). It is usually met with in micaceous, soft, friable scales, having a greyish-black colour, a metallic lustre, an acrid, hot taste, and a disagreeable odour, somewhat similar to that of chlorine. It fuses at about 245° F., and at 347° is volatilised, though the vapour rises along with that of water at 212°. Iodine vapour is of a beautiful violet colour, and has a great specific gravity—namely, 8·716, according to Dumas. Iodine requires 7000 times its weight of water to dissolve it, but alcohol and ether are much better solvents for it.

Characteristics.—In the free state iodine is distinguished from most other bodies by the violet colour of its vapour, and by its forming a blue compound (*iodide of starch*) with starch. So delicate is this test, that, according to Stromeyer, water which does not contain more than one-four-hundred-and-fifty thousandth of its weight of iodine acquires a perceptibly blue tinge on the addition of starch. This blue colour is destroyed by heat; and, therefore, in testing for iodine, the liquids employed should be cold: an excess of alkali also destroys it by forming two salts, an iodate and an iodide, but by supersaturating with acid the colour is restored. The action of iodine on starch is also impeded by some organic constituents of plants.

Indigo-blue, when heated on platinum-foil, evolves a purplish smoke somewhat similar in colour to the vapour of iodine.

Iodine as well as the mineral acids (sulphuric, nitric, and hydrochloric,) produces a blue colour with narceine (see *Opium*).

When iodine is in combination with oxygen, starch will not recognise it. For example, if a little starch be added to a solution of *iodic acid*, no change of colour is observed; but if some deoxidating substance be now employed (such as sulphurous acid) the blue colour is immediately produced. If iodine be combined with a base (as with hydrogen, potassium, or sodium) forming a soluble *iodide*, chlorine or sulphuric or nitric acid must be employed to remove the base; and the iodine being then set free, will react on the starch. This is the mode of proceeding to detect iodine in the urine of a patient; for the mere addition of starch will not suffice. Excess of chlorine will unite with the disengaged iodine, and cause the blue colour to disappear.

[Mons. Rabourdin has shown that chloroform is an exceedingly delicate test for iodine. He applies it as follows:—About three drachms of a solution containing $\frac{100}{1000}$ths of its weight of iodide of potassium is acidulated with two drops of nitric acid, and fifteen to twenty drops of sulphuric acid; about fifteen grains of chloroform are then added. On agitating this the chloroform assumes a violet tint.[2]

Dr. David Price[3] has also lately proposed to detect iodides by mixing the suspected matter with starch paste acidulated with hydrochloric acid and adding a solution of nitrate of potash. A blue colour is produced if iodine be present. In this way he states he has detected the $\frac{1}{4000000}$th part of iodine dissolved in water as iodide of potassium.[3]—ED.]

The metallic *iodides* are known as follows:—Heated with concentrated sulphuric acid in a glass tube, they evolve gaseous iodine, known by its violet colour. The insoluble iodides are frequently characterised by their colour: heated with carbonate of potash, they are decomposed, and yield iodide of potassium. The insoluble iodides are recognised by the action of nitric acid and starch, above mentioned. They yield with nitrate of silver a yellowish-white precipitate (*iodide of silver*), which, like chloride of silver, is insoluble in dilute nitric acid, but, unlike this, is scarcely soluble in caustic ammonia. The iodides also yield a yellow precipitate (*iodide of lead*) with a solution of the salts of lead, and a scarlet precipitate (*biniodide of mercury*) with the perchloride of mercury.

---

[1] Buchner's *Repertorium für die Pharmacie*, 2ter Reihe, Band xx. S. 43, Nürnberg, 1841.

[2] *Pharmaceutical Transactions*, vol. x. p. 551.

[3] *Ibid.* vol. xi. p. 182.

IMPURITIES.—The iodine of commerce is always contaminated with variable proportions of *water*. An ounce, if very moist, may contain a drachm, or perhaps even a drachm and a half, of water. This fraud is detected by compressing the iodine between folds of blotting-paper. In this moist state it is "unfit for making pharmaceutic preparations of fixed and uniform strength," and the Edinburgh College gives the following directions for purifying it:—

> "It must be dried by being placed in a shallow basin of earthenware in a small confined space of air with ten or twelve times its weight of fresh-burnt lime, till it scarcely adheres to the inside of a dry bottle."

To obtain it in large crystals, it requires to be resublimed in an alembic on a sand-bath.

Various substances, such as *coal, plumbago, binoxide of manganese, sand,* and *charcoal,* are also said to have been employed for the purpose of adulterating iodine; but in no samples of iodine which I have examined have I ever found any of these substances. [Dr. Herzog mentions as accidental adulterations, water, chloride of iodine, clay, and cyanide of iodine,—the latter formed by the decomposition of marine animals in the kelp-coal. Sulphuret of antimony, galena, and bitartrate of potash, are quoted by him as intentional adulterations, in addition to those above mentioned. See *Centralblatt*, No. 39, 1850; *Pharm. Trans.* vol. x. p. 311.—ED.] Pure iodine is completely soluble in alcohol, and evaporates, when heated, without leaving any residuum. Any matter insoluble in alcohol, or not vaporizable by heat, is an adulteration.

The London College gives the following note referring to the purity of iodine of commerce:—

> "Black, metallic lustre, having the odour of chlorine. On the application of heat it first fuses, and is then volatilised. It is dissolved by rectified spirit. This liquor gives a blue colour with starch. Thirty-nine grains of iodine dissolved by a gentle heat with nine grains of lime in three ounces of water imbue the liquor with a yellow or brownish colour."

The *Edinburgh College* gives the following criteria of its goodness:—

> "Entirely vaporisable: thirty-nine grains, with nine grains of quicklime and three ounces of water, when heated short of ebullition, slowly form a perfect solution, which is yellowish or brownish, if the iodine be pure, but colourless if there be above two per cent. of water or other impurity."

PHYSIOLOGICAL EFFECTS. α. *On Vegetables*.—Cantu states that seeds placed in pure sand and moistened with a solution of iodine, germinate more readily than seeds sown in the usual way. Vogel, however, asserts that iodine, so far from promoting, actually checks or stops germination.[1]

β. *On Animals generally*.—On horses, dogs, and rabbits, it operates as an irritant and caustic poison, though not of a very energetic kind. Magendie threw a drachm of the tincture of iodine into the veins of a dog without causing any obvious effects.[1] Dr. Cogswell has repeated this experiment: the animal was slightly affected only.[2] The last-mentioned writer found that two drachms of the tincture caused death. But something must be ascribed to the alcohol employed. Orfila[3] applied 72 grains of solid iodine to a wound on the back of a dog: local inflammation, but no other inconvenience, resulted. One or two drachms administered by the stomach caused vomiting, and when this was prevented by tying the œsophagus, ulceration of the alimentary canal, and death, took place. Mr. Dick[4] gave iodine in very large doses to a horse for three weeks, but the only symptom which could be referred to its influence was an unusual disregard for water. The average daily allowance was two drachms, administered in quantities ascending from a drachm up to two ounces. Dr. Cogswell[5] gave 73 grains of iodine to a dog in nine days. Five days after the cessation of the iodine, the dog was killed: the urine contained a highly appreciable quantity of iodine, and a trace, and but a trace, of iodine was found in the blood, brain, and stomach.

---

[1] De Candolle, *Physiologie Végétale*, t. iii. p. 1337.

γ. *On Man.*—The *local* action of iodine is that of an irritant. The nature of its chemical action on the tissues has been already explained (see *ante*, p. 97). Applied to the skin, it stains the cuticle orange-yellow, causes itching, redness, and desquamation. If the vapour of it, mixed with air, be inhaled, it excites cough and heat in the air-passages. On a secreting surface its alcoholic solution acts as a desiccant. Swallowed in large doses, it irritates the stomach, as will be presently mentioned.

The general effects of iodine and its compounds on the body have been already noticed (see *ante*, p. 186). They may be considered under the two heads—of those arising from the use of small, and those produced by large doses.

αα. *In small, medicinal doses,* we sometimes obtain the palliation, or even the removal of disease, without any perceptible alteration in the functions of the body. Thus, in a case of chronic mammary tumor which fell under my observation, iodine was taken daily for twelve months, without giving rise to any perceptible functional change, except that the patient was unusually thin during this period. Sometimes it increases the appetite—an effect noticed both by Coindet[6] and by Lugol,[7] from which circumstance it has been denominated a *tonic*. But the long-continued use of it, in large doses, has occasionally brought on a slow or chronic kind of gastro-enteritis—an effect which I believe to be rare, and only met with when the remedy has been incautiously administered.

In irritable subjects, and those disposed to dyspepsia, it occasions nausea, sickness, heat of stomach, and loss of appetite, especially after its use has been continued for some days; the bowels are oftentimes slightly relaxed, or at least they are not usually constipated. More than one-third of the patients treated by Lugol experienced a purgative effect; and when the dejections were numerous, colics were pretty frequent.[1] Gendrin[2] and Manson,[3] however, observed a constipating effect from the use of iodine.

---

[1] *Formulaire.*

[2] *Experimental Essay on Iodine*, p. 31, 1837.

[3] *Toxicologie générale.*

[4] Cogswell's *Essay*, p. 24.

[5] *Op. cit.* p. 60.

[6] *Biblioth. Univers.* tom. xiv. Sciences et Arts.

[7] *Essays*, translated by Dr. O'Shaughnessy.

The action of iodine on the *organs of secretion* is, for the most part, that of a stimulant; that is, the quantity of fluid secreted is usually increased, though this effect is not constantly observed. Jörg[4] and his friends found, in their experiments on themselves, that small doses of iodine increased the secretion of nasal mucus, of saliva, and of urine, and they inferred that a similar effect was produced on the gastric, pancreatic, and biliary secretions. "Iodine," says Lugol,[5] "is a powerful *diuretic*. All the patients using it have informed me that they pass urine copiously." Coindet, however, expressly says that it does not increase the quantity of urine. In some cases in which I carefully watched its results, I did not find any diuretic effect. Iodine frequently acts as an *emmenagogue*. Coindet, Sablairoles,[6] Brera,[7] Magendie,[8] and many others, agree on this point; but Dr. Manson[9] does not believe that it possesses any emmenagogue powers, further than as a stimulant and tonic to the whole body. In one patient it occasioned so much sickness and disorder of stomach, that the menstrual discharge was suppressed altogether. On several occasions iodine has caused *salivation* and soreness of mouth. In the cases noticed by Lugol the patients were males. In the *Medical Gazette*, vol. xvii. for 1836, two instances are mentioned,—one by Mr. Winslow (p. 401), the other by Dr. Ely (p. 480). Other cases are referred to in Dr. Cogswell's work. This effect, however, I believe to be rare. De Carro (quoted by Bayle[10]) denies that iodine causes salivation, but says it augments *expectoration*. Lastly, *diaphoresis* is sometimes promoted by iodine.

Two most remarkable effects which have been produced by iodine are—*absorption of the mammæ* and *wasting of the testicles*. Of the first of these (absorption of the mammæ), three cases are reported in *Hufeland's Journal*,[11] one of which may be here mentioned. A healthy girl, twenty years of age, took the tincture of iodine during a period of six months for a bronchocele, of which she became cured; but the breasts were observed to diminish in size, and, notwithstanding she ceased to take the remedy, the wasting continued, so that at the end of two years not a vestige of the mammæ remained. Sometimes the breasts waste, though the bronchocele is undiminished: Reichenau[12] relates the case of a female, aged twenty-six, whose breasts began to sink after she had employed iodine for four months, and within four weeks they almost wholly disappeared; yet her goître remained unaffected. With regard to the other effect (wasting of the testicle), I suspect it to be very rare. I have seen iodine administered in some hundreds of cases, and never met with one in which atrophy either of the breast or testicle occurred. Magendie also never saw these effects, though they are frequent in Switzerland.

---

[1] *Op. cit.* p. 20.

[2] *Dict. de Mat. Méd.* t. iii. p. 628.

[3] *Medical Researches on Iodine.*

[4] *Material zu einer Arzneimittell.* Leipzig, 1824.

[5] *Essays*, p. 19.

[6] *Journ. générale de Méd.* t. xcvii.

[7] Quoted by Bayle, in his *Bibliothèque de Thérapeutique*, t. i. p. 129.

[8] *Formulaire.*

[9] *Medical Researches on the Effects of Iodine*, Lond. 1825.

[10] *Op. cit.* p. 50.

[11] Bayle, *op. cit.* p. 162.

[12] Christison, p. 180.

A disordered condition of the cerebro-spinal system has in several instances been caused by iodine. Thus, slight headache and giddiness are not unfrequently brought on. Lugol tells us that, by the use of ioduretted baths, headache, drowsiness, intoxication, and even stupor, are produced. Analogous symptoms were observed in some of Dr. Manson's cases; and in one there were convulsive movements.

A specific effect on the skin is sometimes produced by iodine, besides the diaphoresis before alluded to. Thus Dr. C. Vogel[1] gives an account of a lady, twenty-eight years of age, of a sallow complexion, who, from the internal employment of the tincture of iodine, became suddenly brown, besides suffering with other morbid symptoms. After some days the skin had the appearance of having been smoked! Mr. Stedman[2] says that in some scrofulous patients it improves the condition of the hair and scalp. Red hair is said to have assumed a chesnut-brown colour under the long-continued internal use of iodine.[3]

The rapid emaciation said to have been occasionally produced by iodine, as well as the beneficial influence of this substance in scrofulous diseases, and the disappearance of visceral and glandular enlargements under its use, have given rise to an opinion that iodine *stimulates the lymphatic vessels and glands* (see *ante*, pp. 179 and 180). Manson, however, thinks that it exerts no peculiar or specific influence over the absorbent system, which only participates in the general effect produced on the whole body. And Lugol asserts that instead of producing emaciation it encourages growth and increase of size.

There can be no doubt that the continued use of iodine must have some effect over the general nutrition of the body, and by modifying the actions previously performed by the various organs and symptoms it may at one time cause the *embonpoint* described by Lugol, and at another have the reverse effect: in one case it may promote the activity of the absorbents, and occasion the removal of tumors of considerable size, in another check ulceration (a process which Mr. Key, in the 19th vol. of the *Medico-Chirurgical Transactions*, denies to be one of absorption, but considers to be one of degeneration or disorganisation) and cause the healing of ulcers.

Some have ascribed to iodine an *aphrodisiac* operation. Kolley,[4] a physician at Breslau, who took it for a bronchocele, said it had the reverse effect on him.

In some instances the continued use of iodine has given rise to a disordered state of system, which has been designated *iodism*. The symptoms (termed by Dr. Coindet, *iodic*) are violent vomiting and purging, with fever; great thirst; palpitation; rapid and extreme emaciation; cramps, and small and frequent pulse, occasionally with dry cough; and terminating in death. This condition, however, must be a very rare occurrence; for it is now hardly ever met with, notwithstanding the frequency and freedom with which iodine is employed. But it has been noticed by Coindet,[5] Gardner,[6] Zink,[7] Jahn,[8] and others. The daily experience of almost every practitioner proves that the dangers resulting from the use of iodine have been much exaggerated, and we can hardly help suspecting that many symptoms which have been ascribed to the injurious operation of this remedy ought to have been referred to other causes; occasionally, perhaps, they depended on gastro-enteritis. In some cases the remarkable activity of iodine may have arisen from some idiosyncrasy on the part of the patient. Dr. Coindet attributes the iodic symptoms to the *saturation* of the system with iodine,—an explanation to a certain extent borne out by the results of an experiment made by Dr. Cogswell, and which I have before mentioned: I allude, now, to the detection of iodine in the tissues of an animal five days after he had ceased taking this substance.

---

[1] Rust, *Magazin*, Bd. xiv. p. 156.
[2] *London Medical Gazette*, vol. xv. p. 447.
[3] Clauzel, *Revue Médicale*, Nov. 1834, p. 30.
[4] *Journ. Complém.* t. xvii. p. 307.
[5] *Op. cit.*
[6] *Essay on the Use of Iodine.*
[7] *Journ. Complém.* t. xviii. p. 126.
[8] Quoted by Christison, p. 181.

ββ. *In very large doses* iodine has acted as an irritant poison. In a fatal instance, recorded by Zink,[1] the symptoms were restlessness, burning heat, palpitations, very frequent pulse, violent priapism, copious diarrhœa, excessive thirst, trembling, emaciation, and occasional syncope. The patient died after six weeks' illness. On another occasion this physician had the opportunity of examining the body after death. In some parts the bowels were highly inflamed; in others they exhibited an approach to sphacelation. The liver was very large, and of a pale rose colour. Such cases, however, are very rare. In many instances which might be referred to, enormous quantities of iodine have been taken with very slight effects only, or perhaps with no marks of gastric irritation. Thus, Dr. Kennedy,[2] of Glasgow, exhibited within eighty days 953 grains of iodine in the form of tincture: the daily dose was at first two grains, but ultimately amounted to eighteen grains. The health of the girl appeared to be unaffected by it. It should here be mentioned, that the presence of bread, sago, arrow-root, tapioca, or other amylaceous matters, in the stomach, will much diminish the local action of iodine, by forming an iodide of starch, which, as will hereafter be mentioned, is a very mild preparation.[3]

MODUS OPERANDI.—That iodine becomes absorbed, when employed either externally or internally, we have indisputable evidence by its detection, not only in the blood, but in the secretions (see *ante*, pp. 105 and 106). Cantu[4] has discovered it in the urine, sweat, saliva, milk, and blood. In all cases it is found in the state of iodide. Bennerscheidt[5] examined the serum of the blood of a patient who had employed for some time iodine ointment; but he could not detect any trace of iodine in it. In the crassamentum, however, he obtained evidence of its existence, by the blue tint communicated to starch. It may be readily detected in the urine of patients who have been using iodine, by adding a cold solution of starch and a few drops of nitric acid, when the blue iodide of starch is produced.

USES.—As a remedial agent iodine is principally valuable for its resolvent influence in chronic visceral and glandular enlargements, indurations, thickening of membranes (as of the periosteum), and in tumors. In comparing its therapeutical power with that of mercury, we observe in the first place that it is not adapted for febrile and acute inflammatory complaints, in several of which mercury proves a most valuable agent. Indeed, the existence of inflammatory fever is a contraindication for the employment of iodine. Secondly, iodine is especially adapted for scrofulous, mercury for syphilitic, maladies; and it is well known that in the former class of diseases mercurials are for the most part injurious. Thirdly, the influence of iodine over the secreting organs is much less constant and powerful than that of mercury; so that in retention or suppression of the secretions mercury is for the most part greatly superior to iodine. Fourthly, iodine evinces a specific influence over the diseases of certain organs (*e. g.* the thyroid body), which mercury does not.—These are some only of the peculiarities which distinguish the therapeutical action of iodine from that of mercury.

---

[1] *Journ. Complém.* t. xviii.

[2] Dr. Cogswell's *Essay*.

[3] See the experiments of Dr. Buchanan, presently to be noticed.

[4] *Journ. de Chimie Méd.*

[5] *Ibid.* t. iv. p. 383.

α. In *bronchocele.*—Of all the remedies yet proposed for bronchocele, this has been by far the most successful. Indeed, judging only from the numerous cases cured by it, and which have been published, we should almost infer it to be a sovereign remedy. However, of those who have written on the use of iodine in this complaint, some only have published a numerical list of their successful and unsuccessful cases. Bayle[1] has given a summary of those published by Coster, Irmenger, Baup, and Manson, from which it appears, that of 364 cases treated by iodine, 274 were cured. Dr. Copland[2] observes that, of several cases of the disease which have come before him since the introduction of this remedy into practice, "there has not been one which has not either been cured or remarkably relieved by it." I much regret, however, that my own experience does not accord with this statement. I have repeatedly seen iodine, given in conjunction with iodide of potassium, and used both externally and internally, fail in curing bronchocele; and I know others whose experience has been similar. Dr. Bardsley[3] cured only nine, and relieved six, out of thirty cases, with iodide of potassium. To what circumstances, then, ought we to attribute this variable result? Dr. Copland thinks that where it fails it has been given in "too large and irritating doses, or in an improper form; and without due attention having been paid to certain morbid and constitutional relations of the disease during the treatment."

But, in two or three of the instances before mentioned, I believe the failure did not arise from any of the circumstances alluded to by Dr. Copland, and I am disposed to refer it to some peculiar condition of the tumor, or of the constitution. When we consider that the terms *bronchocele*, *goître*, and *Derbyshire neck*, are applied to very different conditions of the thyroid gland, and that the causes which produce them are involved in great obscurity, and may, therefore, be, and indeed probably are, as diversified as the conditions they give rise to, we can easily imagine, that while iodine is serviceable in some, it may be useless, or even injurious, in others. Sometimes the bronchocele consists in hypertrophy of the substance of the thyroid gland,—that is, this organ is enlarged, but has a healthy structure. In others, the tumefaction of the gland takes place suddenly, and may even disappear as suddenly; from which it has been inferred that the enlargement depends on an accumulation of blood in the vessels, and an effusion of serum into its tissue. Coindet mentions a goître which was developed excessively during the first pregnancy of a young female: twelve hours after her accouchement it had entirely disappeared. The same author also relates the circumstance of a regiment composed of young recruits, who were almost every man attacked with considerable enlargement of the thyroid gland, shortly after their arrival at Geneva, where they all drank water out of the same pump. On their quarters being changed the gland soon regained its natural size in every instance. A third class of bronchoceles consists of an enlargement of the thyroid gland from the development of certain fluid or solid substances in its interior, and which may be contained in cells, or be infiltrated through its substance. These accidental productions may be serous, honey-like, gelatinous, fibrous, cartilaginous, or osseous. Lastly, at times the enlarged gland has acquired a scirrhous condition. Now it is impossible that all these different conditions can be cured with equal facility by iodine: those having solid deposits are, of course, most difficult to get rid of.

---

[1] *Bibliothèque de Thérapeutique*, t. i. p. 394.

[2] *Dict. of Pract. Med.*

[3] *Hospital Facts and Observations*, p. 121.

Kolley, who was himself cured of a large goître of ten years' standing, says, that for the iodine to be useful the bronchocele should not be of too long standing, nor painful to the touch; the swelling confined to the thyroid gland, and not of a scirrhous or carcinomatous nature, nor containing any stony or other analogous concretions; and that the general health be not disordered by any febrile or inflammatory symptoms, or any gastric, hepatic, or intestinal irritation. If the swelling be tender to the touch, and have other marks of inflammation, let the usual local antiphlogistic measures precede the employment of iodine. When this agent is employed, we may administer it both externally and internally. The most effectual method of employing iodine externally is that called *endermic,* already described; namely, to apply an ioduretted ointment (usually containing iodide of potassium), to the cutis vera, the epidermis being previously removed by a blister. But the *epidermic* or *iatroleptic* method is more usually followed—that is, the ioduretted ointment is rubbed into the affected part, without the epidermis being previously removed, or the undiluted tincture is repeatedly applied to the part by a camel's-hair pencil, while iodine is at the same time administered internally.

With respect to the internal use of this substance, some think that the success depends on the use of small doses largely diluted; while others consider that as large a quantity of the remedy should be administered as the stomach and general system can bear.

β. *Scrofula* is another disease for which iodine has been extensively used. Dr. Coindet was, I believe, the first to direct public attention to this remedy in the disease in question. Subsequently, Baup, Gimelle, Kolley, Sablairoles, Benaben, Callaway, and others, published cases illustrative of its beneficial effects.[1] Dr. Manson[2] deserves the credit of having first tried it on an extensive scale. He treated upwards of eighty cases of scrofula and scrofulous ophthalmia by the internal exhibition of iodine, sometimes combined with its external employment; and in a large proportion of cases, where the use of the medicine was persevered in, the disease was either cured or ameliorated, the general health being also improved. Three memoirs on the effects of iodine in scrofula have been subsequently published by Lugol, physician to the Hôpital St.-Louis, serving to confirm the opinions already entertained of its efficacy. From the first memoir it appears that in seventeen months—namely, from August 1827 to December 1828—109 scrofulous patients were treated by iodine only; and that of these 36 were completely cured, and 30 relieved; in 4 cases the treatment was ineffectual, and 39 cases were under treatment at the time of the report made by Serres, Magendie, and Dumeril, to the Académie Royale des Sciences. In his illustrative cases we find glandular swellings, scrofulous ophthalmia, abscesses, ulcers, and diseases of the bones, were beneficially treated by it. Lugol employs iodine internally and externally: for internal administration he prefers iodine dissolved in water by means of iodide of potassium, given either in the form of *drops*, or largely diluted, under the form of what he calls *ioduretted mineral water*, hereafter to be described. His external treatment is of two kinds; one for the purpose of obtaining local effects only, the other for procuring constitutional or general effects. His local external treatment consists in employing ointments or solutions of iodine: the *ointments* are made either with iodine and iodide of potassium, or with the protiodide of mercury; the *solutions* are of iodine and iodide of potassium in water; and according to their strength are denominated caustic, rubefacient, or stimulant: the rubefacient solution is employed in making cataplasms and local baths. His external general treatment consists in the employment of *ioduretted baths*. In the treatment of cutaneous scrofula I have seen the most beneficial results from the application of the tincture of iodine by means of a camel's-hair pencil. It dries up the discharge and promotes cicatrisation.

---

[1] See Bayle's *Bibliothèque de Thérapeutique,* tom. i.

[2] *Op. cit.*

The successful results obtained by Lugol in the treatment of this disease cannot, I think, in many instances, be referred to iodine solely. Many of the patients were kept several months (some as much as a year) under treatment in the hospital, where every attention was paid to the improvement of their general health by warm clothing, good diet, the use of vapour- and sulphur-baths, &c.; means which of themselves are sufficient to ameliorate, if not cure, many of the scrofulous conditions before alluded to. Whether it be to the absence of these supplementary means of diet and regimen, or to some other cause, I know not, but most practitioners will, I think, admit, that they cannot obtain, by the use of iodine, the same successful results which Lugol is said to have met with, though in a large number of cases this agent has been found a most useful remedy.

γ. Iodine has been eminently successful when employed as a resolvent *in chronic diseases of various organs, especially those accompanied with induration and enlargement.* By some inexplicable influence, it sometimes not only puts a stop to the further progress of disease, but apparently restores the part to its normal state. It is usually given with the view of exciting the action of the absorbents, but its influence is not limited to this set of vessels: it exercises a controlling and modifying influence over the blood-vessels of the affected part, and is in the true sense of the word an *alterative* (see *ante*, pp. 179–180).

In chronic inflammation, induration, and enlargement of the *liver*, after antiphlogistic measures have been adopted, the two most important and probable means of relief are iodine and mercury, which may be used either separately or conjointly. If the disease admit of a cure, these are the agents most likely to effect it. Iodine, indeed, has been supposed to possess some specific power of influencing the liver, not only from its efficacy in alleviating or curing certain diseases of this organ, but also from the effects of an over-dose. In one case, pain and induration of the liver were brought on; and in another, which terminated fatally, this organ was found to be enlarged, and of a pale rose colour.[1]

Several cases of enlarged *spleens* relieved, or cured, by iodine have been published.

In chronic diseases of the *uterus,* accompanied with induration and enlargement, iodine has been most successfully employed. In 1828, a remarkable instance was published by Dr. Thetford.[2] The uterus was of osseous hardness, and of so considerable a size as nearly to fill the whole of the pelvis: yet in six weeks the disease had given way to the use of iodine, and the catamenia were restored. In the *Guy's Hospital Reports,* No. I., 1836, is an account, by Dr. Ashwell, of seven cases of "hard tumors" of the uterus successfully treated by the use of iodine, in conjunction with occasional depletion, and regulated and mild diet. Besides the internal use of iodine, this substance was employed in the form of ointment (composed of iodine gr. xv., iodide potassium ℈ij., spermaceti oint. ℥iss.), of which a portion (about the size of a nutmeg) was introduced into the vagina, and rubbed into the affected cervix for ten or twelve minutes every night. It may be applied by the finger, or by a camel's-hair pencil, or sponge mounted on a slender piece of cane. The average time in which resolution of the induration is accomplished varies, according to Dr. Ashwell, from eight to sixteen weeks. "In hard tumors of the walls or cavity of the uterus, resolution, or disappearance, is scarcely to be expected;" but "hard tumors of the cervix, and indurated puckerings of the edges of the os (conditions which most frequently terminate in ulceration) may be melted down and cured by the iodine."[3]

In *ovarian* tumors, iodine has been found serviceable.[4] In the *chronic mammary tumor,* described by Sir A. Cooper, I have seen it give great relief—alleviating pain, and keeping the disease in check. In *indurated enlargements of the parotid, prostate, and lymphatic glands,* several successful cases of its use have been published.

δ. As an *emmenagogue,* iodine has been recommended by Coindet, Brera, Sablairoles, Magendie, and others. The last-mentioned writer tells us, that on one occasion he gave it to a young lady, whose propriety of conduct he had no reason to doubt, and that she miscarried after using it for three weeks. I have known it given for a bronchocele during pregnancy without having the least obvious influence over the uterus.

ε. In *gonorrhœa* and *leucorrhœa* it has been employed with success after the inflammatory symptoms have subsided.

ζ. *Inhalation* of *iodine vapour* has been used in phthisis and chronic bronchitis. In the first of these diseases it has been recommended by Berton, Sir James Murray, and Sir Charles Scudamore. I have repeatedly tried it in this as well as in other chronic pulmonary complaints, but never with the least benefit. The apparatus for inhaling it is the same as that used for the inhalation of chlorine (see *ante,* p. 384). The liquid employed is a solution of ioduretted iodide of potassium, to which Sir C. Scudamore adds the tincture of conium.[1]

---

[1] Christison, *Treatise on Poisons,* pp. 180–1.

[2] *Transactions of the King and Queen's College of Physicians, Ireland,* vol. v.

[3] *Op. cit.* pp. 152–3.

[4] For some remarks, by Sir B. Brodie, on the use of iodine in morbid growths, see Dr. Seymour's *Illustrations of some of the Principal Diseases of the Ovaria,* Lond. 1830. Also, *London Medical Gazette,* vol. v. p. 750.

In the Pharmacopœia of the Parochial Infirmary of St. Marylebone is the following formula for an iodine inhaling liquor :—

Liquor Iodinii ad Inhalationem.—Iodinii, gr. j.; Potassii Iodidi, gr. ss.; Aquæ destillatæ, ʒvij.; Spirit. Vini Rect. ℈iss.; Tinct. Conii saturatæ, ℥j. Drachma una vel drachmæ duæ ex aquâ tepidâ ope tubuli inhaland.

η. *Chronic diseases of the nervous system,* such as paralysis and chorea, have been successfully treated by iodine, by Dr. Manson.

θ. In some forms of *the venereal disease,* iodine has been found a most serviceable remedy. Thus Richond (quoted by Bayle[2]) employed it, after the usual antiphlogistic measures, to remove buboes. De Salle cured chronic venereal affections of the testicles with it. Mr. Mayo[3] has pointed out its efficacy in certain disorders which are the consequences of syphilis, such as emaciation of the frame, with ulcers of the skin; ulcerated throat; and inflammation of the bones, or periosteum,—occurring in patients to whom mercury has been given.

ι. *In checking or controlling the ulcerative process,* iodine is, according to Mr. Key,[4] one of the most powerful remedies we possess. "The most active phagedenic ulcers, that threaten the destruction of parts, are often found to yield in a surprising manner to the influence of this medicine, and to put on a healthy granulating appearance."

κ. Besides the diseases already mentioned, there are many others in which iodine has been used with considerable advantage: for example—*chronic skin diseases,* as lepra, psoriasis, &c.[5] (I have seen it aggravate psoriasis);—*dropsies;*[6] *in old non-united fractures,* to promote the deposition of ossific matter;[7] and *in chronic rheumatism;* but in the latter disease iodide of potassium is more frequently employed. *As an antidote in poisoning by strychnia, brucia,* and *veratria,* iodine has been recommended by M. Donné,[8] because the compound formed by the union of these alkalies with iodine is less active than the alkalies themselves; *as an injection for the cure of hydrocele,* Velpeau[9] has employed a mixture of the tincture of iodine with water, in the proportion of from one to two drachms of the tincture to an ounce of water: of this mixture from one to four ounces are to be injected and immediately withdrawn; lastly, to *check mercurial salivation* iodine has been successfully used.[10]

λ. As *a topical remedy* iodine is exceedingly valuable in several classes of diseases. Dr. Davies,[11] of Hertford, has drawn the attention of the profession to its employment in this way, and pointed out the great benefit attending it. In most cases the tincture is the preparation employed. The part affected is painted with this liquid by means of a camel's-hair pencil. In some few cases only, where the skin is very delicate, will it be necessary to dilute the preparation. When it is required to remove the stain which its use gives rise to, a poultice or gruel should be applied. In *lupus* it proves highly beneficial. My attention was first drawn to its efficacy in this disease by my colleague Mr. Luke. Under its employment the process of ulceration is generally stopped, and cicatrisation takes place. The tincture should be applied, not only to the ulcerated portion, but to the parts around. In *eczema* it also is an excellent application. In *cutaneous scrofula,* likewise, as I have already remarked. In several other cutaneous diseases, such as *lichen, prurigo, pityriasis, psoriasis, impetigo, porrigo, ecthyma,* and *scabies,* Dr. Kennedy[1] has found its use beneficial. According to the testimony of Dr. Davies and an anonymous writer,[2] it is a valuable application to *chilblains.* In the treatment of *diseases of the joints* it is used with great advantage. In *erysipelas* I have seen it highly beneficial. In *phlegmonous inflammation, sloughing of the cellular membrane, inflammation of the absorbents, gout, carbuncle, whitlow, lacerated, contused,* and *punctured wounds,* and *burns* and *scalds,* it is most highly spoken of by Dr. Davies. In *acute rheumatism* and *gout* the application of iodine to the affected parts gives unquestionable relief. Either tincture of iodine or iodine paint (to be described presently) should be applied to the affected joints by means of a camel's-hair pencil, and repeated daily until the cuticle begins to peel off. According to my experience, no remedy gives so much relief as this: I have rarely found it fail. It deserves, however, especial notice, that the skin of different invalids is most unequally susceptible of its influence: in some few it excites so much pain that a second application of it is with difficulty permitted. In others, however, it produces scarcely any painful effects.

---

[1] *London Medical Gazette,* vol. viii. p. 157.

[2] *Op. cit.*

[3] *London Medical Gazette,* vol. xi. p. 249.

[4] *Medico-Chirurg. Trans.* vol. xix.

[5] Cogswell's *Essay,* p. 81.

[6] *Ibid.*

[7] *London Medical Gazette,* vol. vi. p. 512, 1830.

[8] *Journ. de Chim. Méd.* tom. v. p. 494.

[9] *London Medical Gazette,* vol. xx. p. 90.

[10] *Ibid.* vol. xiii. p. 32; and vol. xx. p. 144.

[11] *Selections in Pathology and Surgery,* Lond. 1839.

In *diseases of the lungs and bronchial tubes* simulating phthisis, and also in incipient protracted phthisis, it may be applied to the outside of the thorax with great benefit. It is usually a much less painful application than emetic tartar or croton oil, though, as I believe, equally effective.

Its topical uses are, therefore, nearly as extensive as those of nitrate of silver. Moreover, it is used very much in the same classes of cases, and with the same views.

ADMINISTRATION.—Iodine is rarely administered alone, but generally in conjunction with *iodide of potassium;* to the account of which substance I must refer for formulæ for the combined exhibition of these substances.

In the administration of iodine, care should be taken to avoid gastric irritation. On this account we should avoid giving it on an empty stomach. Exhibited immediately after a meal, its topical action is considerably diminished. This is especially the case when amylaceous substances (as potatoes, bread-pudding, sago, tapioca, and arrow-root) have been taken, as the iodine forms with them an iodide of starch. Iodine has been given in the form of pills, in substance, in doses of about half a grain; but this mode of exhibition is objectionable, and is now never resorted to.

1. TINCTURA IODINII, E.; *Tincture of Iodine.* (Iodine, ℥iiss.; Rect. Spirit, two pints.)—Principally valuable as a topical remedy. For this purpose it is applied as a paint by a camel's-hair pencil. It is also used, mixed with four or six parts of soap liniment, as an embrocation. For internal exhibition it is inferior to the *Tinctura Iodinii composita*, L. D., hereafter to be mentioned. In the first place, by keeping, part of the iodine is deposited in a crystalline form, so that the strength is apt to vary; secondly, it undergoes decomposition, especially when exposed to solar light; the iodine abstracts hydrogen from the spirit, and forms hydriodic acid, one part of which unites with iodine to form ioduretted hydriodic acid, while another, acting on some spirit, forms a little hydriodic ether.[1] These are not the only objections: when added to water, the iodine is deposited in a solid state, and may thus irritate the stomach.

---

[1] *London Medical Gazette,* vol. xxvi. [May 8, 1840], p. 260.
[2] *Ibid.* vol. xxv. [March 20, 1840], p. 943.

Herzog[2] gives the following directions for testing tincture of iodine:—Shake it with an excess of copper filings until it is totally decolorised: the increase of weight which the copper acquires indicates the quantity of iodine. The filtered liquor contains an acid, but no copper; and the decomposition which the tincture has undergone may be judged of by the odour and acid reaction. Calomel produces a yellowish-white precipitate, which subsequently becomes red. Ammoniacal nitrate of silver yields a yellowish-white precipitate, which becomes grey under water.

The dose of the tincture of iodine is ♏v. to fʒss. The best mode of exhibiting it, to cover the flavour, is in sherry wine. When this is inadmissible, sugared water may be employed.

If caustic potash be added to tincture of iodine, the solution becomes colourless, and, after some time, deposits the yellow iodide of formyle (iodoform = FoI^3 or C^2HI^3 or C^2HI,I^2), sometimes called *iodide of carbon*.

2. EMBROCATIO IODINII; *Iodine Paint*.—This is a solution of iodine and iodide of potassium in alcohol: the iodide of potassium greatly facilitates the solution of the iodine. The following is Dr. Todd's[3] formula for it:—Iodinii, gr. lxiv.; Potassii Iodidi, gr. xxx.; Alcohol, ℥j. M.—"The mode of application is by painting the part freely with a camel's-hair pencil. More or less smarting is produced, and frequently vesication or an herpetic eruption may come on. The painting may be repeated as often as circumstances may demand. It is extremely useful where any effusion has taken place into synovial membranes or sheaths."

3. IODIDUM AMYLI, Ph. Ruth.; *Iodide of Starch*.—The following is Dr. Buchanan's[4] formula for preparing this substance:—"Rub 24 grains of iodine with a little water, and gradually add one ounce of finely-powdered starch; dry by a gentle heat, and preserve the powder in a well-stoppered vessel." In persons not labouring under any dyspeptic ailment or constitutional delicacy of habit, Dr. Buchanan commences with half an ounce for a dose, and increases this to an ounce, three times a-day,—equivalent to about 72 grains of iodine daily. It frequently caused costiveness, attended with griping pains of the bowels, and pale-coloured evacuations. Sometimes, though rarely, it produced purging. The dose is ʒss. gradually and cautiously increased. I have found the colour of this preparation objected to by patients.

---

[1] Guibourt, *Pharmaceutical Journal*, vol. vi. p. 184.

[2] *Pharmaceutical Journal*, vol. iv. p. 569.

[3] *Practical Remarks on Gout, Rheumatic Fever, and Chronic Rheumatism of the Joints*, pp. 187–88, Lond. 1843.

[4] *London Medical Gazette*, vol. xviii. p. 515.

4. UNGUENTUM IODINII; *Iodine Ointment.* Formerly contained in the Dublin Pharmacopœia. (Iodine, ℈j.; Prepared Hog's Lard, ℥j.)—This ointment has a rich orange-brown colour; but by keeping, it becomes pale on the surface (partly by the evaporation of the iodine), and hence should always be made when wanted. It is employed as a local application to scrofulous tumors, bronchocele, &c. If it prove too irritating, the quantity of lard should be augmented.

[**5. UNGUENTUM IODINII COMPOSITUM,** L. D.; *Compound Iodine Ointment.* (Iodine, ʒss.; Iodide of Potassium, ʒj.; Rectified Spirit, fʒj.; Lard, ℥ij.) The Dublin College recommends the same proportions of iodine and the iodide, but omits the spirit, making up the two ounces with the ointment of white wax.—This must be regarded as a less irritating preparation than the Unguentum Iodinii of the former Dublin Pharmacopœia, but useful as a local application, promoting absorption.—Ed.]

6. EMPLASTRUM IODINII; *Iodine Plaster.*—Several formulæ for the preparation of an iodine plaster have been published. Of all of them lead plaster is a constituent; and the product, consequently, contains iodide of lead. The following are some formulæ:—

1. *Emplastrum Iodinii.*—Lead Plaster, ʒvj.; Resin Plaster, ʒij. Melt together, and add Iodine, ℈j. rubbed with Olive Oil, ʒss. (Beasley.)
2. *Emplastrum Iodinii* (Roderburg's).—Take ʒss. of Iodine (or ʒj. of Iodide of Potassium), rubbed with a few drops of Spirit and Olive Oil, and incorporated with ℥j. of Simple Plaster previously melted. (Beasley.)
3. *Emplastrum Iodinii Compositum*, Ph. Nosoc. Sancti Georgii.—Iodine, ʒij.; Iodide of Potassium, ʒiij.; Lead Plaster, lb. j.; Opium Plaster, ℥vj. Melt the plasters, then add the iodine and iodide reduced to a very fine powder, and mix.
4. *Emplastrum Iodinii cum Belladonnâ.*—Iodine, ℥ss. to ℥ij.; Venice Turpentine, ʒij.; Olive Oil, ʒj.; Belladonna Plaster, lb. j. Mix and spread with a cool iron. (Beasley.)

Antidotes.—In the event of poisoning by iodine, or its tincture, the first object is to evacuate the poison from the stomach. For this purpose, the vomitings are to be assisted by the copious use of tepid demulcent liquids, especially by those containing amylaceous matter; as starch, wheaten flour, potatoes, sago, or arrow-root, which should be boiled in water, and exhibited freely (see *ante*, p. 165). The efficacy of these agents depends on their combining with the iodine to form iodide of starch, which has very little local action. In their absence, other demulcents, such as milk, eggs beat up with water, or even tepid water merely, may be given to produce vomiting. Magnesia is also recommended. Opiates have been found useful. Of course the gastro-enteritis must be combated by the usual means.

19. Acidum Iodicum.—Iodic Acid.

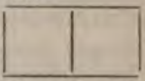
Formula IO^5. *Equivalent Weight* 166.

Oxiodine.—Obtained by boiling iodine with nitric acid; or by decomposing iodate of baryta[1] by dilute sulphuric acid. Iodic acid is a white transparent solid, slightly deliquescent, and very soluble in water. It is composed of iodine 126 and oxygen 40. It is deoxidised by sulphuretted hydrogen, sulphurous acid, and morphia; iodine being set free in each case (hence iodic acid is used as a test for morphia). The iodates, when heated, evolve oxygen, and are converted into iodides. A solution of an iodate causes, with nitrate of silver, a whitish precipitate, which is difficultly soluble in nitric acid, but soluble in ammonia. It has been employed in medicine by Mr. Monks,[1] the house-surgeon to the Poor-Law Schools, Norwood. He gives it in combination with disulphate of quina (which is rendered soluble by it as by sulphuric acid) as a tonic, stimulant, and alterative, in hoarseness consequent on catarrh, strumous cases, incipient phthisis, chronic inflammation, syphilis, &c. Unlike iodide of potassium, it can be given in combination with sulphuric or nitric acid without suffering decomposition. The dose of it for children of from 7 to 14 years of age is three grains; for adults, from three to six or more grains. Its general effects on the system agree with those of iodine.

---

[1] *Iodate of baryta* is prepared by heating together 80 parts of iodine, 75 of chlorate of potash, 1 of nitric acid, and 400 of water: the iodine disappears, chlorine is evolved, and iodate of potash formed in solution. The latter is decomposed by 90 parts of nitrate of baryta (or 72 parts of chloride of barium), by which iodate of baryta is precipitated.

20. Acidum Hydriodicum.—Hydriodic Acid.

Formula HI. *Equivalent Weight* 127. *Equivalent of the Gas* 2 or 

Iodhydric Acid; Hydriod.—Obtained in the gaseous form by the action of water on iodide of phosphorus. Like gaseous hydrochloric acid, this gas fumes in the air. By its reaction on bases (metallic oxides), it yields water and iodides (see *ante*, p. 388). As a medicine, it has been employed in the form of an aqueous solution, which is directed by Dr. Buchanan[2] to be prepared as follows:—Dissolve 330 grs. of Iodide of Potassium in ℥iss. of Distilled Water, and to this add 264 grs. of Tartaric Acid, also dissolved in ℥iss. of Distilled Water. When the Bitartrate of Potash has subsided, strain; and to the strained liquor add sufficient water to make fifty drachms (=f℥vj. ʒij.) KI+T+2HO =KO,HO,T+HI. This solution, according to Dr. Buchanan, possesses all the therapeutical powers of iodine, without its irritating properties. He has given as much as ʒj. of it three times a-day, or ʒij. of iodine daily. He regards ℥ss. as the ordinary dose; but it would be much safer to begin with a smaller dose.

21. SULPHURIS IODIDUM.—IODIDE OF SULPHUR.

Formula S^2I. *Equivalent Weight* 158.

HISTORY.—This compound was first described by Gay-Lussac.[3]

PREPARATION.—It is prepared by heating gently, in a clean oil flask, four parts of iodine with one part of sulphur until fusion is effected. Part of the iodine volatilises, and the remainder unites with the sulphur.

PROPERTIES.—It is a black crystallisable compound, having the colour and radiated appearance of sesquisulphuret of antimony. It has the odour of iodine, and stains the cuticle, paper, &c. like this substance. Its elements are easily separated by heat.

Characteristics.—Boiled in water, the iodine volatilises with the steam, and the sulphur is deposited nearly in a state of purity.

COMPOSITION.—Its composition has not been determined. It is probably the following:—

	Atoms.	*Eq. Wt.*	*Per Cent.*
Iodine	1	126	79·75
Sulphur	2	32	20·25
Iodide of Sulphur	1	158	100·00

---

[1] *Medical Times*, October 3, 1846.

[2] *London Medical Gazette*, vol. xviii. p. 517.

[3] *Ann. de Chimie*, xci. 22, 1814.

PHYSIOLOGICAL EFFECTS. *a. On Animals.*—Dr. Cogswell[1] gave three drachms to a bitch. The animal lost her appetite, was dull, and, on the fourth day, could not support herself properly upon her legs. On the twelfth day she was well.

β. On Man.—Its constitutional effects are probably like those of iodine. Its local operation is that of a powerful irritant and resolvent.

USES.—Iodide of sulphur has been principally employed, in the form of ointment, in various skin diseases, especially the squamous and tubercular forms. In *lupus* it has been found most efficacious by Biett,[2] as well as Rayer.[3] The last-mentioned writer places it in the foremost rank of local remedies for this disease. In *acne indurata* and *rosacea* it has proved highly useful in the hands of Biett,[4] Rayer,[5] and Dr. Copland.[6] In *lepra,* Rayer has observed good effects from its use; but in one case in which I tried it, it caused so much irritation that its use was obliged to be discontinued. In *herpes pustulosus labialis* it has been employed with great success by Dr. Volmar.[7] In *tinea capitis* it has also been recommended.[8] In chronic *eczema* of the ears an ointment of it has been used.

Dr. Copland[9] has employed the inhalation of the vapour of this substance in humoral asthma with temporary advantage.

Galtier gave internally from gr. j. to gr. vj. daily, in the form of pill.

UNGUENTUM SULPHURIS IODIDI, L.; *Ointment of Iodide of Sulphur.* (Iodide of Sulphur, ʒss.; Lard, ℥j.)—Magendie recommended 1 part of iodide to 18 or 19 of lard, and the London preparation is 1 to 16.

22. Iodinii Chloridum.—Chloride of Iodine.

Two compounds of iodine and chlorine are known, viz. the *protochloride* ICl, a reddish-brown liquid,—and the *perchloride* ICl^3, a solid yellow substance. Both are obtained by exposing iodine to the action of chlorine. Dr. Turnbull[10] tried the effects of the vapour of the "chloruret of iodine" (protochloride?) on the eye: it produced very little warmth or uneasiness to the eye when continued for the space of two minutes or upwards; but a sensation of irritation, accompanied with a flow of tears, on its removal. It contracted the pupil. Its vapour did not leave the yellow disagreeable colouring on the skin produced by the vapour of iodine.

---

[1] *Experimental Essay on Iodine and its Compounds.*
[2] Cazenove and Schedel, *Abrégé pratiq. sur les Malad. de la Peau.*
[3] *Treatise on Diseases of the Skin,* translated by Dr. Willis.
[4] *Op. cit.*
[5] *Op. cit.* p. 476.
[6] *Dict. of Pract. Med.* art. *Acne,* p. 31.
[7] Dierbach, *Die neuesten Entdeck. in d. Mat. Med.* 2te Ausg. Bd. i. S. 449.
[8] *London Medical Gazette,* vol. xx. p. 879.
[9] *Op. cit.* art. *Asthma,* p. 149.
[10] *London Medical Gazette,* Nov. 5, 1842.

ORDER IX. BROMINE.

23. BROMINIUM.—BROMINE.

Symbol Br. *Equivalent Weight* 80.[1] *Equivalent Volume of the Vapour* 1 or □

HISTORY.—This substance was discovered by M. Balard, of Montpellier, in 1826. He at first termed it *muride* (from *muria*, brine), in allusion to the substance from whence he procured it; but, at the suggestion of Gay-Lussac, he altered this name to that of *brome,* or *bromine* (from *βρῶμος, a stink*), on account of its unpleasant odour.

NATURAL HISTORY.—It is found in both kingdoms of nature, but never in the free state.

α. IN THE INORGANISED KINGDOM.—Bromide of silver has been found in Mexico (Berthier). Hollander detected brome in an ore of zinc, and Cochler recognised it in Silesian cadmium.[2] It exists in sea-water and many mineral waters, especially brine springs, in combination with either sodium, magnesium, or calcium. Thus it has been found in the waters of the Mediterranean, the Baltic, the North Sea, the Frith of Forth, the Dead Sea, many of the brine springs of Europe and America (as those of Middlewich, Nantwich, Ashby-de-la-Zouch, and Shirleywich, in England), and in many other mineral springs of Europe and America (as the Pittville spring at Cheltenham, the water of Llandrindod and of Bonnington). The saline springs near Kreuznach in Germany are especially rich in it. It has been justly observed by Dr. Daubeny,[3] that the detection of bromine in brine springs is a fact interesting in a geological point of view, as tending to identify the product of the ancient seas, in their most minute particulars, with those of the present ocean.

β. IN THE ORGANISED KINGDOM.—Bromine has been found in the sea-plants of the Mediterranean, and in the mother-waters of Kelp. It has likewise been detected in various marine animals. Thus in the Sea-Sponge *(Spongia officinalis)*, in the stony concretion found in this animal, in the ashes of the *Janthina violacea,* one of the gasteropodous mollusca, and in cod-liver oil.

PREPARATION.—Bromine is obtained from *bittern* (the mother-liquor of sea-water, from which chloride of sodium has been separated by crystallisation); from kelp; or from the mother-ley of the salt springs near Kreuznach, in Germany. From thirty pounds of the concentrated ley, Liebig obtained twenty ounces of bromine. Of these springs, that of Karshall contains, according to Dr. G. Osann,[4] 6·6025 grs. of bromide of calcium, and 1·3672 grs. of bromide of magnesium, in sixteen ounces of the water. According to the same authority, 100 parts of the mother-ley of the Münster-am-Stein spring contain 24·12 parts of bromide of calcium, and 0·48 parts of bromide of magnesium. Sixteen ounces of the mother-ley of the Theodorshall spring contain 338·72 grs. of bromide of calcium, and 92·82 grs. of bromide of magnesium.

---

[1] The atomic weight of bromine, according to Berzelius, is 78·4 [78·26, Graham]. This number has been usually pretty closely adhered to by chemical writers, and is adopted by the learned L. Gmelin in the first part of his *Handbuch*. But the later researches of Marignac appear to prove that about 80 is the real number; and accordingly L. Gmelin has adopted this in the second or organic part of his *Handbuch*. It is remarkable that 80 is the number adopted by Thomson (*System of Chemistry*, 7th edit. vol. i. 1831).

[2] Gmelin, *Handbuch der Chemie.*

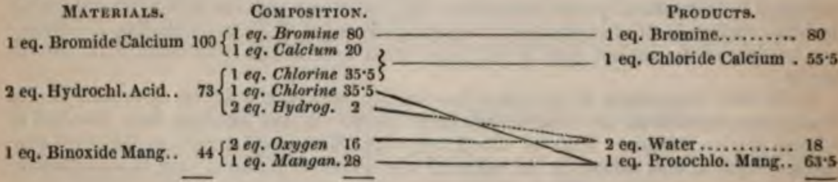
[3] *Phil. Trans.* 1830.

[4] G. W. Schwartze's *Allgemeine und specielle Heilquellenlehre*, Abt. 1, S. 224, Leipzig, 1839.

Bromine is thus obtained from bittern:—Having deprived the mother-liquor of sea-water, as much as possible, of its other salts, by crystallisation, chlorine is developed in it (either by binoxide of manganese and hydrochloric acid; or, when the quantity of metallic chloride is sufficient, by binoxide of manganese and sulphuric acid). This decomposes the metallic bromide (magnesium) contained in the liquor, and sets free bromine, which distils over: $MgBr + Cl = MgCl + Br$. The bromine thus obtained requires to be subsequently purified.

The process followed at Kreuznach, according to Dr. Mohr,[1] is that recommended by Defosses,[2] but modified by Löwig.[3] To about four quarts of the mother-ley contained in a retort are added one ounce of binoxide of manganese, and five or six ounces of commercial hydrochloric acid. On the application of the heat of a sand-bath, water and bromine pass over into the receiver. When all has passed over, the vapour is observed to be colourless, and to consist of aqueous vapour and hydrochloric acid.

The following is the theory of the process:—Two equivalents of hydrochloric acid react on one equivalent of binoxide of manganese, and yield one equivalent of protochloride of manganese, two equivalents of water, and one equivalent of chlorine; the latter, in its nascent state, reacts on one equivalent of bromide of calcium, and produces one equivalent of chloride of calcium and one equivalent of free bromine. $CaBr + MnO^2 + 2HCl = CaCl + MnCl + 2HO + Br$.



The mixture of binoxide of manganese and hydrochloric acid is rendered too dilute by the mother-ley to produce, by their reaction, free chlorine, when no bromide is present with whose base it can combine. Hence, when all the bromine has passed over, we find hydrochloric acid, and not chlorine, in the vapour which is passing over.

Properties.—At ordinary temperatures, bromine is a dark-coloured very volatile liquid, which, seen by reflected light, appears blackish red, but viewed in thin layers, by transmitted light, is hyacinth red. Its odour is strong and unpleasant, its taste acrid. Its sp. gr. is 2·966, Balard (2·98 to 2·99, Löwig), water being 1. When exposed to a cold of $-4°$ F. ($-13°$ F. Liebig) it is a yellowish-brown, brittle, crystalline solid. At ordinary temperatures, liquid bromine evolves ruddy vapours (similar to those of nitrous acid), so that a few drops put into a small vessel immediately fill it with the vapour of bromine. At 116½° F. bromine boils. The vapour is not combustible: a lighted taper plunged into it is immediately extinguished; but before the flame goes out, it becomes red at the upper and green at the lower part. Antimony or arsenicum take fire when dropped into liquid bromine; when potassium or phosphorus is dropped in, a violent explosion takes place. Bromine is a non-conductor of electricity; it is a bleaching agent; it dissolves in about 34 parts of water (*bromine water*), more so in alcohol, and much more so in sulphuric ether. It communicates a fine orange colour to starch.

---

[1] *Annalen der Pharmacie*, Bd. xxii. S. 66, Heidelberg, 1837.

[2] *Journ. de Chim. Méd.* t. iii. p. 256, 1827.

[3] *Das Brom und seine chemischen Verhältnisse*, Heidelberg, 1829.

Characteristics.—Liquid bromine is recognised by its colour, odour, volatility, and the colour of its vapour. To these characters must be added, its powerful action on antimony, arsenicum, and potassium, before mentioned, its dissolving in ether, forming a hyacinth-red liquid, and the orange colour which it communicates to starch. It causes a yellowish white precipitate (*bromide of silver*) with a solution of the nitrate of silver. In its external appearance it resembles the terchloride of chromium and the chloride of iodine. I have known it confounded with tincture of iodine.

The soluble *bromides* cause white precipitates with the nitrate of silver, acetate of lead, and protonitrate of mercury. The precipitates are bromides of the respective metals. Bromide of silver is yellowish-white, clotty, insoluble, or nearly so, in boiling nitric acid and in a weak solution of ammonia (by which it is distinguished from chloride of silver), but dissolves in a concentrated solution of this alkali. Bromine is liberated from bromide of silver by the action of hydrochloric acid and chloride of lime. Heated with sulphuric acid, it evolves vapours of bromine. If a few drops of a solution of chlorine be added to a solution of a bromide, and then a little sulphuric ether, we obtain an ethereal solution of bromine of a hyacinth-red colour, which floats on the water.

The *bromates* when heated evolve oxygen, and become bromides. The bromates cause white precipitates (*metallic bromates*) with the nitrate of silver and the protosalts of mercury. Bromate of silver is not soluble in nitric acid, but dissolves readily in solution of ammonia. If a few drops of hydrochloric acid be added to a bromate, and then some ether, a yellow or red ethereal solution of bromine is obtained.

IMPURITIES.—Water, chlorine, and iodine, are the substances with which the bromine of commerce is apt to be contaminated. Bromine is usually kept in the shops under a layer of water, for the purpose of preventing loss by evaporation. To obtain anhydrous bromine (which is rarely required), ordinary bromine must be distilled from fused chloride of calcium. The compound of chlorine and bromine is soluble in water; but repeated washing with water will only in part abstract the chlorine with which bromine is combined.

PHYSIOLOGICAL EFFECTS. *α. On Vegetables.*—I am unacquainted with any experiments made with bromine on plants.

β. On Animals generally.—The action of bromine on animals has been examined by Franz,[1] by Barthez, by Butzke,[2] by Dieffenbach,[3] and by Glover.[4] The animals experimented on were leeches, fishes, birds, horses, rabbits, and dogs. It acts as a local irritant and caustic, and, therefore, when swallowed, gives rise to gastro-enteritis. Injected into the jugular vein it coagulates the blood and causes immediate death, preceded by tetanic convulsions. No positive inferences can be drawn as to the specific influence of bromine on any organs of the body. Some of the symptoms (such as dilated pupil, insensibility, and convulsions) would seem to indicate a specific affection of the brain. Franz frequently observed inflammation of the liver.

---

[1] Quoted by Wibmer, *Die Wirkung d. Arzneim.* 1er Bd. S. 433; also in *Journ. Chim. Méd.* tom. v. p. 540.

[2] *De Efficacia Bromi interna experimentis illustrata*, Berol. 1829.

[3] Christison, *On Poisons*, p. 187.

[4] *Edinb. Med. and Surg. Journ.* No. 152.

γ. *On Man.*—The chemical action of bromine on the tissues has been before (p. 96) noticed. The general effects of it have also been referred to (see *ante*, p. 186). It stains the cuticle yellowish-brown, and, by continued application, acts as an irritant. Its vapour is very irritating when inhaled, or applied to the mucous lining of the nose, or to the conjunctiva. Franz, by breathing the vapour, had violent cough, and a feeling of suffocation, followed by headache. Butzke swallowed a drop and a half of bromine in half an ounce of water, and experienced heat in the mouth, œsophagus, and stomach, followed by colicky pains. Two drops occasioned nausea, hiccup, and increased secretion of mucus. The irritating action of bromine on the alimentary canal is shown by the liquid stools and diarrhœa.

The constitutional effects resulting from the continued use of bromine have not been well determined: they are probably intermediate between chlorine and iodine; but, according to Dr. Glover, more nearly related to the former than to the latter. Bromine acts in small doses as a tonic, diuretic, and resolvent.

Hitherto no cases of poisoning with it in the human subject have been seen.

USES.—It seems to possess the same therapeutic influence as iodine, and has been administered in bronchocele, in scrofula, in diseases of the spleen, in tumors, in amenorrhœa, in eczema, and against hypertrophy of the ventricles. It is usually regarded as possessing more activity than iodine. Löwig has used it as a disinfectant.

ADMINISTRATION.—It may be administered dissolved in water. An aqueous solution, composed of one part by weight of bromine and forty parts of water, may be given in doses of five or six drops, properly diluted and flavoured with syrup. This solution has also been used as an external agent in lotions. It has been used also in the form of ointment, composed of 10 to 15 grs. to ℥j. of lard. (For other formulæ, see *Bromide of Potassium.*)

ANTIDOTES.—The treatment of cases of poisoning by bromine should be the same as for poisoning by iodine. Barthez has recommended magnesia as an antidote.

ORDER X. NITROGEN AND ITS COMPOUNDS WITH OXYGEN AND HYDROGEN.

24. Nitrogenium.—Nitrogen.

Symbol N. *Equivalent Weight* 14. *Equivalent Volume* 1 or □

This gas was first recognised, in 1772, by Dr. Rutherford, who termed it *mephitic air*. Priestley called it *phlogisticated air*. Lavoisier named it *azote* (from *a*, *not*; and ζωή, *life*). Cavendish, finding it to be a constituent of nitric acid, gave it the appellation it now usually bears, *nitrogen* (from νίτρον, *nitre*; and γεννάω, *I beget* or *produce*).

It is found in both kingdoms of nature. It has not hitherto been found in non-fossiliferous rocks; but it is a constituent of coal, of nitrates, of ammoniacal salts, and of some mineral waters. It forms from 79 to 80 per cent. of the atmosphere. It is a constituent of various organic principles (as the alkaloids, albuminous principles, gelatine, mucus, urea, uric acid, &c.) It is found in the swimming bladders of fishes.

The readiest method of procuring it is to burn a piece of phosphorus in a confined portion of atmospheric air. The phosphorus combines with the oxygen of the air and forms metaphosphoric acid. The residual gas, after being thoroughly washed, is nearly pure nitrogen.

It is a colourless, odourless, tasteless gas; is without action on vegetable colours; and is neither combustible nor a supporter of combustion. It does not whiten lime water. Its sp. gr. is 0·971. It is very slightly absorbed by water. It is usually distinguished by its negative properties just described.

In organic analysis the nitrogen is estimated either in the free state, as gas, or, by Will and Varrentrapp's method, in the form of ammonia. If an organic substance containing nitrogen be heated with a mixture of caustic soda and quicklime, the nitrogen is evolved in the form of ammonia.

The effects of nitrogen gas on vegetables and animals are analogous to those of hydrogen before mentioned (see *ante*, p. 280). Thus, when inspired, it acts as an asphyxiating agent, by excluding oxygen; when injected into the blood it acts mechanically only. It is an essential constituent of the air employed in respiration.

It has been mixed with atmospheric air, and inspired in certain pulmonary affections, with the view of diminishing the stimulant influence of the oxygen, and thereby of acting as a sedative.

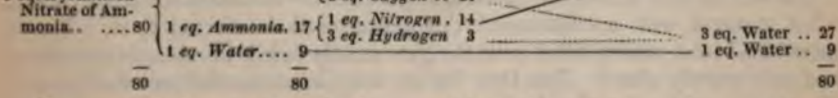
25. NITROGENII PROTOXYDUM.—PROTOXIDE OF NITROGEN.

Formula NO. *Equivalent Weight* 22. *Equivalent Volume* 1 or □

HISTORY.—This gas was discovered by Dr. Priestley in 1776. He termed it *dephlogisticated nitrous air*. Sir H. Davy[1] called it *nitrous oxide*. Its common name is *laughing gas*. It is always an artificial product.

PREPARATION.—It is obtained by heating nitrate of ammonia in a glass retort. The heat employed should be sufficient to fuse the salt and keep it in a state of gentle ebullition. If the heat be too high, white fumes are evolved.

Every equivalent of the crystallised salt is resolved into four equivalents of water and two equivalents of protoxide of nitrogen, $NH^3,HO,NO^5 = 2NO + 4HO$.



If we regard the crystallised salt as a nitrate of ammonium, the equation is as follows:—$NH^4O,NO^5 = 2NO + 4HO$.

1lb. avoirdupois (=7000 grs. troy) of nitrate of ammonia should evolve about 4½ cubic feet of gas.

PROPERTIES. *a. Of the gaseous oxide.*—At ordinary temperature and pressure, it is a colourless gas, with a faint, not disagreeable odour, and a sweetish taste. It is not combustible, but is a powerful supporter of combustion, almost rivalling in this respect oxygen gas. It does not affect vegetable colours, and undergoes no change either of colour or of volume when mixed with oxygen or binoxide of nitrogen. Its sp. gr. is 1·52.

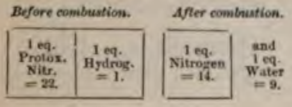
---

[1] *Researches, Chemical and Philosophical, chiefly concerning Nitrous Oxide, or Dephlogisticated Nitrous Air, and its Respiration*, 1800.

β. *Of the liquid oxide.*—When subjected to a pressure of 50 atmospheres, at 45° F., it is condensed into a limpid, colourless, very volatile liquid, which does not freeze itself by evaporation as liquid carbonic acid does.

γ. *Of the solid oxide.*—At a temperature of about −150° F., Faraday succeeded in solidifying protoxide of nitrogen. In this form, it is a clear, crystalline, colourless body.

Characteristics.—The only gas with which it is possible to confound it is oxygen, with which it agrees in being colourless, not combustible, but a powerful supporter of combustion, re-inflaming a glowing match. From this it may be readily distinguished by its not yielding ruddy vapours (*nitrous acid gas*) when binoxide of nitrogen is mingled with it; and by mixing it with an equal volume of hydrogen, and exploding it by the electric spark, by which we obtain one volume of nitrogen and an equivalent of water. If a taper be burnt in a jar of this gas over water, the flame is surrounded with a purplish halo, and there is produced a brown vapour (*nitrous acid gas*).



Impurities.—The gas may be rendered impure by the use either of an impure nitrate or of too high a temperature. If the nitrate contain sal-ammoniac, chlorine is disengaged: this may be detected by its odour and by its action on nitrate of silver (see *ante*, p. 381). If too high a temperature be employed in the preparation of the salt (and which may be known by the evolution of white vapours [hyponitrite of ammonia?]), the obtained gas is irritating, and often contains binoxide of nitrogen, the presence of which is known by the red fumes produced on mixing the gas with oxygen. The presence of oxygen or common air may be detected by mingling some binoxide of nitrogen with the suspected gas, when red fumes are produced.

Composition.—Its composition is as follows:—

	Atoms.	*Eq. Wt.*	*Per cent.*	*Davy.*
Nitrogen	1	14	63·6	63·3
Oxygen	1	8	36·4	36·7
Protoxide Nitrogen	1	22	100·0	100·0

	Vol.	*Sp. gr.*
Nitrogen gas	1	0·97
Oxygen gas	0·5	0·55
Protoxide Nitrogen Gas	1	1·52

Physiological Effects. *a. On Vegetables.*—Germinating seeds (peas), when watered with a solution of this gas, seemed unaffected by it. Plants introduced into vessels filled with the gas mostly faded in about three days, and died shortly after.[1] But Drs. Turner and Christison did not find that it was injurious to vegetation.[2]

β. *On Animals.*—The effects of this gas on insects, annelides, mollusca, amphibials, birds, and mammals, were examined by Sir H. Davy. On all it acted as a positive poison. It produced "peculiar changes in their blood and in their organs, first connected with increased living action, but terminating in death." Slowly injected into the veins of animals, considerable quantities were found by Nysten to produce slight staggering only; larger quantities produced the same disorder of the nervous system noticed when the gas is respired.[1]

---

[1] Davy's *Researches.*

[2] Christison, *On Poisons*, p. 756.

γ. *On Man.*—When inhaled, its effects on the nervous system are most remarkable: I have administered this gas to about one hundred persons, and have observed that after the respiration of it from a bladder for a few seconds, it usually causes frequent and deep inspiration, blueness of the lips and countenance, an indisposition to part with the inhaling tube, and a temporary delirium, which subsides in the course of three or four minutes. The sensations are usually pleasing. The delirium manifests itself differently in different individuals; as in some by dancing, in others by fighting, &c. In some few cases I have seen stupor produced. Singing in the ears, giddiness, and tingling sensations in the hands and feet, are sometimes experienced.

In a case mentioned by Professor Silliman, the after-effect of the gas was a complete perversion of the sense of taste for eight weeks (A. S. Taylor).

It produces a state of anæsthesia (see *ante*, p. 208) or insensibility to pain during surgical operations.[2]

Some serious after-effects on the lungs and brain have occasionally followed the inhalation of it in common experiments (A. S. Taylor).

USES.—It has been employed in some few cases only of disease. Beddoes used it in paralysis with benefit, but found it injurious to the hysterical and exquisitely sensible.[3] In a remarkable case of spasmodic asthma, related by Mr. Curtis,[4] it acted beneficially. In a second case it also gave relief. It has been employed in the treatment of melancholy.

DOSE.—For medicinal purposes one or two quarts may be inhaled daily from a bladder or pneumatic trough. Its use requires caution. The breathing-tube should have a side aperture closed with a cork, which can be removed should the patient evince an unwillingness to relinquish the tube.

AQUA NITROGENII PROTOXYDI; *Protoxide of Nitrogen Water; Aqua Azotica Oxygenata; Searle's Patent Oxygenous Aërated Water.*—At ordinary temperature and pressure, water dissolves about three-fourths of its own bulk of protoxide of nitrogen; but by pressure the quantity may of course be augmented. The patent solution is said to contain five times its bulk of gas; or each bottle of the liquid is stated to hold a full quart of gas. Its effects on the system are not very marked. Sir H. Davy drank nearly three pints of the ordinary solution in one day, and says that it appeared to act as a diuretic; and he adds, "I imagined that it expedited digestion." Serullas[5] employed protoxide of nitrogen water (made at the ordinary temperature and pressure of the atmosphere) in the treatment of Asiatic cholera. The patients took six or eight pints within five or six hours: during the day their warmth returned, the blueness disappeared. It has also been employed to counteract the evil consequences of inebriety. The proprietor of the patent water asserts that it exhilarates, and is adapted for torpor, debility, fatigue, depression of spirits, asthma, dyspepsia, &c.; but is contraindicated in inflammatory and plethoric states of system.—Dose, six or eight ounces taken two or three times a day between meals, or as the ordinary beverage.

---

[1] *Recherches*, pp. 77–8.

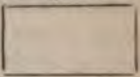
[2] *Account of a New Anæsthetic Agent as a Substitute for Sulphuric Ether in Surgery and Midwifery*, by J. Y. Simpson, M.D., p. 16, 1847.

[3] Davy's *Researches*, p. 542.

[4] *Lancet*, vol. ii. for 1828–9.

[5] *Journ. de Chim. Méd.* t. viii. pp 309 and 441, 1832.

26. Nitrogenii Binoxydum.—Binoxide of Nitrogen.

Formula NO^2. *Equivalent Weight* 30. *Equivalent Volume* 2 or 

Nitrous gas; nitric oxide; nitrous air; deutoxide of nitrogen.—Known to Hales; but first accurately examined by Priestley in 1772. It is procured in great abundance by dissolving copper filings or clippings in nitric acid, and collecting the gas over water. $4NO^5+3Cu=NO^2+3(CuO,NO^5)$. It is a colourless gas, whose sp. gr. is 1·08. It is a supporter of combustion. It forms red fumes of hyponitric (nitrous) acid when mixed with oxygen gas or atmospheric air. $NO^2+2O=NO^4$. It dissolves in a solution of protosulphate of iron, to which it communicates a dark greenish-brown or olive colour. This compound, which is said to be definite, and to consist of $4(FeO,SO^3)+NO^2$, communicates a red or purplish colour to a large quantity of cold oil of vitriol (see *ante*, p. 368). The odour, taste, and effects of the gas, when taken into the lungs, are unknown; because, immediately an attempt is made to inhale it, it absorbs oxygen from the air, and is converted into hyponitric (nitrous) acid. Sir H. Davy rashly tried to inspire it (having previously exhausted his lungs of air by making three inspirations and expirations of protoxide of nitrogen), but the attempt fortunately failed by the production of spasm of the glottis, to which occurrence he considered he owed his life.—In pharmacy, binoxide of nitrogen is useful as a test for oxygen (see *ante*, pp. 274 and 420), and on account of its characteristic reaction on the solution of protosulphate of iron (see pp. 368 and 426).

27. ACIDUM NITRICUM.—NITRIC ACID.

Formula NO^5. *Equivalent Weight* 54.

HISTORY.—Liquid or hydrated nitric acid was known in the seventh century to Geber, who termed it *solutive water*.[1] The nature of its constituents was shown by Cavendish in 1785, and their proportions were subsequently determined by Davy, Gay-Lussac, and Thomson. It is sometimes called ***azotic acid***.

NATURAL HISTORY.—It is found in both kingdoms of nature.

α. IN THE INORGANISED KINGDOM.—Combined with potash, soda, lime, or magnesia, it is found on the surface of the earth in various parts of the world. The nitrates have been found in some few mineral waters. Thus, there is a district of Hungary, between the Carpathians and the Drave, where all the springs, for the space of about 300 miles, contain a small quantity of the nitrate of potash.[2] It is found in rain water after a thunder-storm. It also occurs in well waters as a result of animal decomposition (see p. 298).

β. IN THE ORGANISED KINGDOM.—Nitric acid in combination with bases (potash, soda, lime, and magnesia) is a frequent constituent of vegetable juices.[3]

[PREPARATION.—Dry uncombined nitric acid has been prepared lately by M. Deville. He obtained it by subjecting nitrate of silver to the action of chlorine gas. The result was—chloride of silver, oxygen, and dry nitric acid.

PROPERTIES.—Anhydrous nitric acid is colourless, crystallising in 6-sided columns, which fuse at 86° Fahr., and boil between 113° and 122°, at which temperature they begin to decompose. Anhydrous nitric acid has been known to explode spontaneously. It dissolves in water, producing much heat, and forming the hydrated acid.

---

[1] *Of the Invention of Verity*, ch. xxi. and xxiii.

[2] Gairdner, *On Mineral Springs*, p. 20.

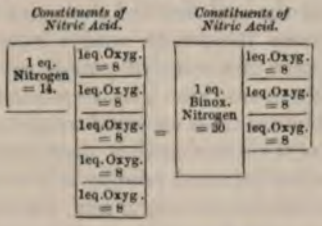
[3] De Candolle, *Physiol. Végét.* t. i. pp. 388, 387, and 403, also Johnston's *Lectures on Agricultural Chemistry*, 2d edit. 1847.

COMPOSITION.—Its composition is—

Nitrogen.. 14, or 1 atom.
Oxygen .... 40, or 5 atoms.[1]—ED.]

Anhydrous or *dry nitric acid*, such as we find it in some nitrates, has the composition by weight as above, viz.:—

	Atoms.	*Eq.Wt.*	*P.Ct.*	*Lavoisier.*	*Cav.*	*Berz.*	*Davy.*		*Vols.*		*Vols.*
Nitrogen..	1	14	25·9	20	25	26	29·5	Nitrogen	1	Binox. Nitrogen	2
Oxygen ..	5	40	74·1	80	75	74	70·5	Oxygen..	2·5	Oxygen........	1·5
Nitric Acid	6	54	100·0	100	100	100	100				



Liquid or Watery Nitric Acid.

SYNONYMES.—*Nitrate of water; hydrate of nitric acid; nitric acid* (*acidum nitricum*) of the pharmacopœias and shops; *spirit of nitre* (*spiritus nitri*); *Glauber's spirit of nitre* (*spiritus nitri Glauberi*).

When liquid nitric acid is red and fuming from the presence of nitric acid it is called *fuming nitric acid* (*acidum nitricum fumans*), or commonly *nitrous acid* (*acidum nitrosum*).

The term *aqua fortis* (either *single* or *double*) is applied to a more dilute acid than the preceding.

PREPARATION.—Liquid nitric acid is usually obtained by submitting to distillation a nitrate (either of potash or soda), with oil of vitriol.

Formerly it was procured by submitting to distillation a mixture of nitre and either sulphate of iron or clay.[2] Mr. de Sussex has recently proposed the use of lime and a nitrate.

The London College no longer retains a formula for preparing this acid, but places it in the materia medica with the following note for testing the purity of the commercial acid:—

"Colourless; specific gravity, 1·42; exposed to air, it gives out most acrid vapours; totally volatilised by heat; diluted with three parts of water by measure, it yields no precipitate on the addition either of nitrate of silver or chloride of barium. 100 grains of this acid are saturated by 161 grains of crystals of carbonate of soda."

The Edinburgh College uses equal weights of dried nitrate of potash and sulphuric acid. The directions it gives for obtaining pure nitric acid (*acidum nitricum purum*) are as follows:—

---

[1] *L'Institut*, Fevrier 21, 1849.
[2] See Quincy's *Complete English Dispensatory*, 14th edit. pp. 292–4, 1769.

"Purify nitrate of potash, if necessary, by two or more crystallisations, till nitrate of silver does not act on its solution in distilled water. Put into a glass retort equal weights of this purified nitrate and of sulphuric acid, and distil into a cool receiver, with a moderate heat from a sand-bath or naked gas-flame, so long as the fused material continues to give off vapour. The pale-yellow acid thus obtained may be rendered colourless, should this be thought necessary, by heating it gently in a retort."

The Dublin College orders the nitrate of potassa to be tested by nitrate of silver, in order that any hydrochloric acid present may be precipitated. The liquor is then ordered to be filtered, evaporated to dryness, and treated with commercial oil of vitriol. The specific gravity of the acid obtained is fixed at 1·500. The proportion of ingredients ordered is, Nitre, lbs. ij.; Nitrate of Silver, ʒij., or as much as may be necessary; Boiling Distilled Water, Ov.; Oil of Vitriol, ℥xvij. The heating of the retort is to be carried on to the fusing of its contents, and the acid distilled through a Liebig's condenser.

Nitric acid manufacturers frequently employ nitrate of soda (sometimes called Chili saltpetre) instead of nitrate of potash in the preparation of this acid; and Knapp[1] says there are three advantages attending its use; viz. the quantity of nitric acid obtained from an equal weight of the salt is greater, the cost of the salt is less, and the nitric acid is disengaged at a lower temperature, and consequently a less coloured product is obtained.

When the object is to obtain pure nitric acid, the distillation is effected in a glass retort and receiver; but the common nitric acid of commerce is usually procured by means of an iron or stoneware still.

The apparatus used on the large scale is generally that employed in the manufacture of hydrochloric acid (see *ante*, p. 390); namely, an iron or stoneware pot, with a stoneware head, which is connected with a row of double-necked stoneware bottles containing water. Another form of apparatus employed by some manufacturers, is an iron cylinder, set in brickwork over a fire-place, and connected with a row of five or six double-necked stoneware bottles each containing about $\frac{1}{8}$th of their capacity of water.

I was informed by a manufacturer that the charge employed for one of these cylinders was 168lbs. of nitrate of potash and 93lbs. of oil of vitriol, sp. gr. 1·485. These quantities are nearly in the proportion of eight equivalents of acid to seven equivalents of nitrate. Different manufacturers, however, employ somewhat different proportions.

The acid obtained by the process of the Pharmacopœia has a sp. gr. of 1·42; that procured by the ordinary process is brown and fuming, and has a sp. gr. of from 1·425 to 1·45. This is the *nitrous acid* or *fuming nitric acid* of commerce. To render it colourless it is heated in a glass retort, placed in a sand-bath. The colourless acid thus obtained has a sp. gr. of from 1·35 to about 1·4, and constitutes the *nitric acid of commerce* (*acidum nitricum venale*). The residue in the iron cylinder is a mixture of sulphate with a little bisulphate of potash, and is sold as *sal enixum*. It is employed as a flux, and in the manufacture of alum.

Theory.—The explanation of the changes which take place in the manufacture of nitric acid is somewhat modified by the strength of the sulphuric acid employed, and by the proportion of the ingredients used. Assuming the oil of vitriol employed to have a sp. gr. of 1·8433 (that is, to be composed of about four equivalents of real sulphuric acid and five equivalents of water), and that an equal weight of nitrate of potash be used, the changes which occur will be as follows: Four equivalents of dry sulphuric acid, and five equivalents of water react on two equivalents of nitrate of potash, and produce two equivalents of strong liquid nitric acid (sesquihydrate) and one equivalent of hydrated bisulphate of potash. $2(KO,NO^5)+5(HO,4SO^3=2KO,2SO^3)+3HO,2NO^5$.

---

[1] *Chemical Technology*, vol. i. pp. 420–1, 1848.

MATERIALS.		COMPOSITION.		PRODUCTS.	
2 eq. Nitrate Potash........	202	2 *eq. Nitric Acid*	108	2 Sesquihydrate Nitric Acid	135
		2 *eq. Potash*	94		
4 eq. Liquid Sulphuric Acid (Sp. gr. 1·8433.)	205	3 *eq. Water*	27		
		2 *eq. Water*	18		
		4 *eq. Sulph. Acid*	160	2 Hyd. Bisulphate Potash ..	272
	407		407		407

The generation of nitrous acid is greatest at the commencement and towards the close of the operation; for, at the commencement, the excess of uncombined sulphuric acid attracts water from the small quantity of nitric acid then set free, in consequence of which the latter is resolved into nitrous acid and oxygen; about the middle of the process, when the quantity of free nitric acid has been increased, while that of the sulphuric acid has diminished, the former passes over with water unchanged; but towards the end of the process, owing to the volatilisation of the nitric acid, the sulphuric acid becomes again predominant, and the red vapours of nitrous acid then make their appearance.

PROPERTIES.—Strong and pure liquid nitric acid (*acidum nitricum purum*) is colourless, and has a peculiar odour, and an acrid, intensely sour taste. In the air it evolves white fumes, formed by the union of the acid vapour with the aqueous vapour of the atmosphere; these fumes redden litmus, and become much whiter when mixed with the vapour of ammonia, owing to the formation of the nitrate of ammonia. The strongest colourless acid of the shops has a sp. gr. of 1·45; and the ordinary colourless acid does not usually exceed 1·35 to 1·4. The sp. gr. of the acid, prepared according to the London Pharmacopœia (1836) is 1·5033 to 1·504; and Mr. Phillips believed this to be the strongest procurable; but Proust says he obtained it as high as 1·62; Kirwan, 1·554; Davy, 1·55; Gay-Lussac, 1·510; Thénard, 1·513; and more recently Millon obtained it at 1·521. The Edinburgh College fixes the density of pure nitric acid at 1·500, and that of commercial acid at from 1·380 to 1·390. Acid of this density has a slight yellow tinge. At 248° F., nitric acid, of sp. gr. 1·42, boils: acid either denser or less dense than this boils at a low temperature. At $-40°$ F. the concentrated acid congeals. Nitric acid has a powerful affinity for water; and, when mixed with it, heat is evolved.

Nitric acid is easily deoxidised. Thus, exposure to solar light causes the evolution of oxygen and the production of nitrous acid, which gives the liquid a yellow, orange, or reddish-brown colour. The acid thus coloured may be rendered colourless, but of course weaker, by the application of a gentle heat, to drive off the nitrous acid. Several of the non-metallic combustibles rapidly decompose the nitric acid; as charcoal, phosphorus, sugar, alcohol, volatile oils, resins, &c. The acid is unacted on by leaf-gold, platinum, &c. Some of the metals[1] also act powerfully on it, as copper (in the form of turnings), and tin (in the state of foil). A little water added to the acid facilitates, in some cases, the action of metals on it. The hydracids (as hydrochloric acid) decompose, and are decomposed by, nitric acid.

---

[1] For an account of the anomalous relations of this acid and iron, I must refer the reader to Becquerel's *Traité d'Electricité*, tom. v. p. 8; also Brande's *Man. of Chem.* vol. i. p. 723, 1848.

ACIDUM NITROSO-NITRICUM; *Fuming nitric acid* (*acidum nitricum fumans*); *Spiritus nitri fumans*; *Nitrous acid* (*acidum nitrosum*) of commerce.—This is a mixture or compound of nitric and nitrous acids with some water. It may be procured by adding nitrous acid to concentrated nitric acid; or by passing binoxide of nitrogen into concentrated nitric acid. The commercial nitrous acid is obtained by the distillation of nitrate of either soda or potash with oil of vitriol. When an equal number of atoms of nitrate of potash and strong oil of vitriol are submitted to distillation, the first products are hydrated nitric acid, bisulphate of potash, and undecomposed nitrate. $2(HO,SO^3)+2(KO,NO^5)=HO,NO^5+KO,HO,2SO^3+KO,NO^5$. At a higher temperature the bisulphate reacts on the nitrate, and expels the nitric acid, which is resolved into oxygen and nitrous acid, $NO^5=O+NO^4$. The latter dissolves in the hydrated nitric acid and produces fuming nitric acid—the nitrous acid of the shops.

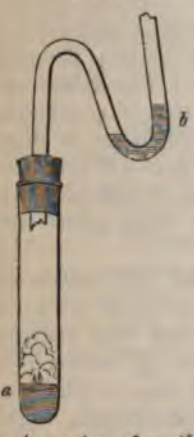
It is a coloured liquid, the colour varying with the quantity of nitrous acid which it contains: usually it is yellowish-red. It fumes in the air, and gives out a darker yellowish-red vapour (nitrous acid). The sp. gr. of the most concentrated acid is 1·500; but that of the shops varies from 1·425 to 1·450. When the strong acid is exposed to a cold of −56°·2 F. it congeals into a very dark red mass. It is a more corrosive acid than concentrated nitric acid, as it more readily gives out oxygen with the development of more heat and light. Thus it acts more violently on the metallic sulphurets than ordinary nitric acid, and is therefore used for the purpose of oxidising them. By the addition of an alkali to the fuming acid, binoxide of nitrogen is evolved, and a nitrate and hyponitrite formed. If the fuming acid be gently heated in a retort, nitrous acid is evolved, and there is left behind colourless nitric acid whose density is less than that of the fuming acid.

AQUA FORTIS DUPLEX; *Double Aqua Fortis*.—This is liquid nitric acid of sp. gr. 1·36. It is used by jewellers for dissolving metals, and by colour-makers.

AQUA FORTIS SIMPLEX; *Single Aqua Fortis*.—This is liquid nitric acid of sp. gr. 1·22 to 1·25. It is employed principally by dyers for dissolving tin.

Characteristics.—Nitric acid is known by the following characters:—It stains the cuticle, quills, &c. yellow or orange: mixed with copper filings, effervescence takes place, owing to the escape of binoxide of nitrogen, and a greenish-blue solution of nitrate of copper is obtained: the binoxide forms ruddy vapours in the air, by uniting with oxygen to form nitrous acid gas; and, passed into a solution of the protosulphate of iron, forms a dark olive-brown-coloured liquid. To the liquid suspected to contain nitric acid add at least ¼th of its volume of pure oil of vitriol; and when the mixture is cold, add protosulphate of iron, when a dark purplish or brownish colour is developed. Nitric acid decolorises sulphate of indigo. Morphia or brucia communicates a red colour to nitric acid, which is heightened by supersaturating the liquid with ammonia: powdered nux vomica renders this acid yellow or orange-coloured. If hydrochloric acid be added to nitric acid, the mixture acquires the power of dissolving leaf-gold: the presence of gold in solution may be recognised by the protochloride of tin, with which it strikes a purple or blackish colour. Lastly, saturated with pure carbonate (or bicarbonate) of potash, a nitrate of potash is procured.

FIG. 71.



Apparatus for the Detection of Nitric Acid.

The *nitrates* are known by the following characters:—They evolve oxygen when heated, and deflagrate when thrown on a red-hot cinder or charcoal; when heated with sulphuric acid they disengage nitric acid, which may be recognised by its action on morphia, brucia, or commercial strychnia; lastly, when mixed with sulphuric acid and copper-turnings, they generate binoxide of nitrogen, which is readily recognised by its blackening a solution of sulphate of the protoxide of iron. This last-mentioned property enables us to recognise very minute portions of the nitrates. The nitrate, copper-filings, and sulphuric acid, are to be put into the test-tube (fig. 71, *a*), to which is adapted, by means of a cork, a small curved glass tube, containing at the bend (*b*) a drop or two of the solution of the protosulphate of iron; heat is to be applied to the mixture in the test-tube, and in a few minutes the ferruginous solution becomes brown or blackish (see *ante*, p. 368). [This test fails when much chloride is mixed with a nitrate. It is then advisable to add strong hydrochloric acid and gold-leaf to the suspected nitrate, and boil the mixture. The solution of the gold shows that a nitrate is present, and the smallest proportion of gold dissolved may be detected by adding to the liquid a few drops of chloride of tin.—ED.]

COMPOSITION.—Liquid or watery nitric acid is composed of dry or real nitric acid and water. The strongest acid obtained by Millon was a monohydrate.

When the sp. gr. is 1·5033 to 1·504, the liquid acid is, according to Mr. Phillips, a sesquihydrate; when the sp. gr. is 1·486, the acid, according to Dr. Ure, is a binhydrate.

	Millon's strongest Acid.			Sp.gr.1·5033to1·504.			Sp. gr. 1·486.			Sp. gr. 1·42.		
	Atoms.	*Eq.Wt.*	*P.Ct.*	*At.*	*Eq.Wt.*	*P.Ct.*	*At.*	*Eq.Wt.*	*P.Ct.*	*At.*	*Eq.Wt.*	*P.Ct*
Dry Nitric Acid	1	54	85·7	1	54	80	1	54	75	1	54	60
Water	1	9	14·3	1½	13·5	20	2	18	25	4	36	40
Liquid Nitric Acid	1	63	100·0	1	67·5	100	1	72	100	1	90	100

One hundred grains of nitric acid, sp. gr. 1·5, saturate about 217 grains of carbonate of soda, equal to about 81 grains of real or dry nitric acid.

According to Mr. Graham, acid whose sp. gr/is 1·42 is the proper nitrate of water; and of the four atoms of water which it contains, one is combined with the acid as a base, and may be termed *basic* water, while the other three are in combination with the nitrate of water, and may be termed the *constitutional* water of that salt. HO,NO^5+3HO. This is the acid of the present London Pharmacopœia.

IMPURITIES.—The ordinary impurities of commercial nitric acid are, excess of water, nitrous acid, chlorine, and sulphuric acid.

The presence of an excess of water is detected by the low sp. gr. The presence of nitrous acid is known by the colour of the acid being yellow or orange. Its origin has been before explained (see *ante*, p. 426).

According to Millon,[1] the best test for the presence of nitrous acid is an aqueous solution of sulphuretted hydrogen. If this be added to the suspected acid which has been previously diluted with once or twice its volume of water, the least trace of nitrous acid causes the liberation of sulphur, which gives an opalescent appearance to the liquor. At the same time a small quantity of ammonia is formed.

To detect chlorine (which is derived from the alkaline chlorides contained in the nitrate, and in the manufacture of nitric acid), dilute with distilled water, and apply nitrate of silver; a white chloride of silver is precipitated, which is insoluble in nitric acid, but soluble in ammonia. To recognise sulphuric acid (carried over from the acid in the still or retort), add a solution of nitrate of baryta or chloride of barium to the acid previously diluted with water; a heavy white sulphate, insoluble in nitric acid, is thrown down.

---

[1] *Pharmaceutical Journal*, vol. ii. p. 355.

When nitric acid has been obtained from Chili nitrate of soda, it is apt to be contaminated with iodine (derived from the alkaline iodide contained in the Chili nitrate) or iodic acid, formed by the oxidation of iodine. The presence of iodine is detected by starch (see *ante*, p. 399). Nitric acid coloured brownish by iodine, loses its colour by keeping, owing to the oxidation of the iodine and its conversion into iodic acid. To detect iodic acid, add sulphurous acid and starch to the diluted nitric acid: the sulphurous acid deoxidises the iodic acid, and the starch produces a blue colour with the iodine. This blue colour, it must be remembered, does not appear if the solution be warm. It is destroyed by alkalies, and reappears on neutralisation with a mineral acid.

Purification.—For nitric acid whose sp. gr. does not exceed 1·48, the best method of purification is to add one part of bichromate of potash to every hundred of acid, and distil. The nitrous acid is transformed into nitric acid at the expense of the oxygen of the chromic acid.

Physiological Effects. *a. On Vegetables.*—Nitric acid decomposes the different vegetable tissues to which it may be applied, and gives them a yellow colour.

β. On Animals.—Orfila found that 26 grains of commercial nitric acid, injected into the jugular vein, coagulated the blood, and caused death in two minutes.[1] Viborg threw a drachm of the acid, diluted with three drachms of water, into the jugular vein of two horses; in two hours they were well: the blood, when drawn, was slightly coagulated.[2] Introduced into the stomach of dogs, it disorganises this viscus, and causes death in a few hours.

γ. On Man.—On the *dead body*, M. Tartra has made various experiments to determine the appearances produced by the action of nitric acid. Of course this caustic decomposes the organic textures; but the phenomena presented vary according to different circumstances—as the quantity employed, the presence of other substances, &c.

The chemical action of nitric acid on the tissues has been already noticed (see *ante*, p. 97).

On the *living body*, its action varies with the degree of concentration or dilution of the acid. In the concentrated form the acid acts as a powerfully corrosive poison, which property it derives in part from its affinity for water, but more especially from the facility with which it gives out oxygen; so that the appearances caused by its action on some of the tissues are different from those produced by sulphuric acid. The permanent yellow stain (xantho-proteic acid) which it communicates to the cuticle is peculiar to it. Iodine stains the skin yellow or brown, but a little caustic potash readily removes the stain when recent; whereas the yellowish stain produced by nitric acid becomes orange on the addition of an alkaline soap. Bromine also stains the skin yellow; but when recently produced, the colour may also be removed by potash. The yellow or citron stain communicated to the lining membrane of the tongue, pharynx, &c. by nitric acid, has been well shown by Dr. Roupell[1] A preparation, presenting similar appearances, is preserved in the anatomical museum of the London Hospital. Nitric, like sulphuric acid, also chars the animal tissues; and thus, after the ingestion of it, the stomach is sometimes found blackened, as if sulphuric acid had been swallowed. The symptoms are analogous to those produced by sulphuric acid (see *ante*, p. 370). The yellow, citron, or orange spots sometimes observed on the lips, chin, or face, will, when present, at once indicate the kind of acid swallowed. Sometimes the binoxide of nitrogen is evolved by the mouth.

---

[1] *Toxicolog. Générale.*

[2] Wibmer, *Die Wirkung*, &c.

Properly diluted, nitric acid produces effects similar to those of the other mineral acids (see *ante*, p. 174). It is said, however, to act less evidently as a tonic, and to be more apt to disagree with the stomach, so that it cannot be employed for so long a period. In some cases it has excited ptyalism, and from this circumstance, as well as from the occasional benefit derived from its use in the venereal disease, it has by some writers been compared, in its operation, to mercury,—a comparison founded rather on theoretical than practical considerations.

USES. *a. Internal.*—As nitric acid produces certain effects, in common with other mineral acids, it may be used as a substitute for the latter in various diseases. Thus, it is administered in conjunction with the bitter infusions in those conditions admitting of, or requiring, the use of tonics. Properly diluted, it is employed as a refrigerant in febrile disorders. In lithiasis, attended with phosphatic deposits in the urine, it has been used instead of the sulphuric or hydrochloric acid. As a lithonlytic injected into the bladder, very dilute nitric acid has been successfully employed by Sir B. Brodie (see *ante*, p. 266). In some obstinate cutaneous diseases, as impetigo, it is given to the extent of half a drachm daily in barley water.[2] It may be employed, also, to relieve heartburn.

In 1793 this acid was used by Mr. Scott, a surgeon at Bombay, as a substitute for mercurial preparations which Girtanner erroneously fancied owed their efficacy to the quantity of oxygen which they contained. Mr. Scott first tried it in chronic hepatitis, and with considerable success. He then extended its use to venereal diseases, and obtained the happiest results from it.

Subsequently it has been most extensively employed in the last-mentioned diseases; but the success attending its use has been variable. That it has been, and is frequently serviceable, no one can doubt who reads the immense body of evidence offered in its favour by Scott, Kellie, Albers, Prioleau, Rollo, Cruickshank, Beddoes,[3] Ferriar, and others. But, on the other hand, it is equally certain that on very many occasions it has been useless. The same remark, indeed, may be made of mercury, or of any other remedy; but as an anti-venereal medicine it does not admit of comparison with this metal. However, we frequently meet with syphilitic cases in which the employment of mercury is either useless or hurtful. Thus it can rarely be employed with advantage in scrofulous subjects; or in persons whose idiosyncrasies render them peculiarly susceptible to the influence of this metal; and in sloughing sores it is inadmissible. Now these are the cases in which nitric acid may be employed with benefit; and I believe the best mode of administering it is in conjunction with the compound decoction of sarsaparilla.

---

[1] See his *Illustrations of the Effects of Poisons.*

[2] Rayer, *Treatise on the Diseases of the Skin*, p. 502.

[3] *Reports, principally concerning the Effects of the Nitrous Acid in Venereal Disease*, Bristol, 1797.

For further information respecting its employment, I must refer to the works of Holst[1] and Mr. Samuel Cooper.[2]

β. *External.*[3]—In the *concentrated* state, nitric acid has been employed as a powerful escharotic (see *ante*, p. 161); as to destroy warts, and as an application to parts bitten by rabid animals or venomous serpents, to phagedænic ulcers, &c. In order to confine the acid to the spot intended to be acted on, the neighbouring parts may be previously smeared with some resinous ointment. In sloughing phagedæna, the application of strong nitric acid, as recommended by Mr. Welbank,[4] is attended with the most successful results, as I have on several occasions witnessed. The best mode of applying it is by a piece of lint tied round a small stick or skewer. When the slough is very thick, it is sometimes necessary to remove part of it with a pair of scissors, in order to enable the acid to come in contact with the living surface.

Largely *diluted* (as 50 or 60 drops of strong acid to a pint or quart of water) it is recommended by Sir Astley Cooper as a wash for sloughing and other ill-conditioned sores.

In the form of *ointment* it is used in various skin diseases, especially porrigo and scabies, and as an application to syphilitic sores.

Nitric acid vapour has been employed as a disinfectant (see *ante*, p. 166), but it is probably inferior to chlorine. It was first introduced for this purpose by Dr. Carmichael Smyth[5] (to whom Parliament granted a reward of £5000): hence these fumigations have been termed *fumigationes nitricæ Smythianæ*. The vapour is readily developed by pouring one part of oil of vitriol over one part of nitrate of potash in a saucer placed on heated sand.

ADMINISTRATION.—The dose will depend on the concentration of the acid. The usual statement in pharmacological works applies to the commercial nitric acid and to the acid of the pharmacopœia (sp. gr. 1·42). The latter is so strong that it ought not to be dispensed in small quantities, "as it is impossible to measure a few minims with so much accuracy as a proportionate quantity of the diluted acid."[6] (See *Acidum Nitricum Dilutum*).

ANTIDOTES.—Poisoning by nitric acid requires precisely the same treatment as that by sulphuric acid (see *ante*, pp. 164 and 372).

1. ACIDUM NITRICUM DILUTUM. L. E. D.; *Diluted Nitric Acid.* (Nitric Acid, f℥iij.; Distilled Water, f℥xvij. *L.*; Pure Nitric Acid (sp. gr, 1·500), f℥j.; and Distilled Water, f℥ix.; or, Commercial Nitric Acid (sp. gr. 1·390), f℥j. and fʒvss.; and Distilled Water, f℥ix. *E.* Nitric Acid, f℥iv.; Distilled Water, f℥xxix. *D.*)—The sp. gr. of the Diluted Nitric Acid of the London Pharmacopœia is 1·082. A fluidounce of this acid is saturated by 154 grains of crystallised carbonate of soda. The following is its composition :—

---

[1] *De Acidi Nitrici Usu Medico Dissertatio*, Christianæ, 1818.

[2] *Dictionary of Practical Surgery.*

[3] On the external use of nitric acid, see *London Medical Repository*, vol. xiv. p. 450, 1820.

[4] *Medico-Chirurg. Trans.* vol. xi.

[5] *The Effects of the Nitrous Vapour in preventing and destroying Contagion*, London, 1799: reviewed in the *London Medical Review*, vol. i. p. 433, Lond. 1779.

[6] *Pharmaceutical Journal*, vol. iii. p. 112–14.

	Per Cent.		*Per Cent.*
Dry or real nitric acid	12·22	Strong liquid nitric acid (sesquihydrate)	15·27
Water	87·78	Water	84·73
Diluted Nitr ic Acid, *Ph. L.*	100·00	Diluted Nitric Acid, *Ph. L.*	100·00

The diluted nitric acid of the Edinburgh Pharmacopœia (1814) has a sp. gr. of 1·077 ; and it contains 11·16 of dry or real nitric acid.

The diluted nitric acid of the Dublin Pharmacopœia has a sp. gr. of 1·092 ; and is stronger than that of the London and Edinburgh Pharmacopœias.

The strength of this preparation varies considerably in the shops, owing to the employment of nitric acid of different densities in its preparation. When prepared with acid whose sp. gr. is that of the Pharmacopœia (1·42), its strength is far beyond that prepared with the ordinary colourless nitric acid of the shops (sp. gr. 1·350).

The dose of the dilute nitric acid of the London and Edinburgh Pharmacopœias is—♏xx. to ♏xl. (equal to ♏ij. and ♏iv. of strong nitric acid).

The dose of the dilute nitric acid of the Dublin Pharmacopœia is from ♏vij. to ♏xv.

The above doses apply to the dilute nitric acid made according to the directions of the Pharmacopœias; that is, with nitric acid, sp. gr. 1·42. Much larger doses may of course be given when this preparation is made with the ordinary commercial nitric acid, sp. gr. 1·35 to 1·4.

Some useful cautions respecting the dose of properly prepared dilute nitric acid have been given by Mr. Bell.[1] Alluding to the dose of ♏xl. of the acid of the London Pharmacopœia, he says, "we have no hesitation in stating that this quantity is quite sufficient, *unless largely diluted*, to act injuriously on the enamel of the teeth ;" and he mentions a case in which six minims of the strong acid (equal to fʒj. of the dilute acid), taken in an ounce of fluid three times a day, seriously injured the teeth in two or three days.

Larger doses than those above stated may be administered if properly diluted. The medicine may be taken by sucking it through a quill or glass tube, and the mouth should be rinsed with either water or an alkaline solution immediately after each dose.

2. **UNGUENTUM ACIDI NITRICI**; *Oxygenised Fat ; Pommade d'Alyon.* (Olive Oil, lb. j. ; Prepared Hog's-Lard, ℥iv. ; Nitric Acid, by measure, ʒvss. Having melted the oil and lard in a glass vessel, when they are beginning to become concrete, add the acid ; then stir them constantly with a glass rod until they become firm.)—The constituents of the fatty substances suffer oxidation at the expense of the nitric acid.—The changes are complicated and the products numerous (see *Unguentum Hydrargyri Nitratis*). This ointment has a firm consistence and a yellow colour. Its uses have been above noticed. It is more efficacious when recently prepared. It existed as a preparation in a late edition of the Dublin Pharmacopœia, but is now excluded.

---

[1] *Pharmaceutical Journal*, vol. iii. p. 113.

28. ACIDUM NITRO-HYDROCHLORICUM.—NITRO-HYDROCHLORIC ACID.

HISTORY.—This liquid was known to Geber.[1] It was formerly called *aqua regia*. It is commonly known as *nitro-muriatic acid* (*acidum nitro-muriaticum*).

PREPARATION.—It is prepared by mixing hydrochloric acid with nitric acid. The directions of the Dublin Pharmacopœia (1850) for its preparation are as follows:—

> Take of pure Nitric Acid, by measure, one part; pure Muriatic Acid, by measure, two parts. Mix the acids in a green glass stoppered bottle, and keep the mixture in a cold place.

In the arts, a solution having the power of dissolving gold is sometimes prepared by adding nitre to hydrochloric acid, or common salt or sal-ammoniac to nitric acid.

The precise nature of nitro-hydrochloric acid is somewhat obscure. According to Davy,[2] by the reaction of one equivalent of nitric acid on one equivalent of hydrochloric acid, we obtain one equivalent of nitrous acid, one equivalent of chlorine, and an equivalent of water. $\mathrm{NO^5 + HCl = NO^4 + HO + Cl}$.

MATERIALS.	COMPOSITION.	PRODUCTS.
1 eq. Hydrochloric Acid 36·5	1 *eq. Chlorine* .... 35·5	1 eq. Chlorine ... 35·5
	1 *eq. Hydrogen* ... 1	1 eq. Water 9
1 eq. Nitric Acid 54	1 *eq. Oxygen* 8	
	1 *eq. Nitrous Acid* 46	1 eq. Nitrous Acid 46
90·5	90·5	90·5

But the reaction of these substances is influenced by temperature, by the degree of concentration of the acids, and by the presence of a substance capable of combining with chlorine. Usually "the mutual decomposition of the two acids proceeds only so far as to saturate the liquid with chlorine" (Brande). If, however, heat be applied to expel the liberated chlorine, or if a metal be introduced to absorb it, the decomposition goes on until one or both of the acids are exhausted.

Mr. E. Davy[3] ascribes the solvent power of aqua regia to chloro-nitrous gas ($\mathrm{NO^2Cl^2}$) dissolved in the liquid. This gas is produced by the mutual reaction of nitric acid and common salt. $\mathrm{4NO^5 + 3NaCl = 3(NaO,NO^5) + Cl + NO^2Cl^2}$.

Baudrimont,[4] on the other hand, states that by the mutual action of nitric and hydrochloric acids, *chloro-nitric* (*chloro-azotic*) *acid* is produced, which is the effective solvent of the mixture. $\mathrm{4NO^5 + 2HCl = NO^3Cl + 2HO}$. This view, however, has been contested by Koene.[5]

PROPERTIES.—It has a yellow colour. Its most remarkable property is that of dissolving gold and platinum, metals that are insoluble in either nitric or hydrochloric acid separately. It should be kept in a cool dark place; for heat rapidly expels the chlorine, while light enables it to decompose the water and to form hydrochloric acid.

---

[1] *Invention of Verity*, chap. xxiii.

[2] *Journal of Science and the Arts*, vol. i. p. 67, 1816.

[3] *Phil. Mag.* vol. ix. p. 355.

[4] *Journal de Pharmacie*, 3me sér. tom. v. p. 49, 1844.

[5] Poggendorff's *Annalen*, Bd lxiv. S. 429, 1845.

Characteristics.—It is recognised by its colour, by its power of dissolving gold, by its precipitating a solution of the nitrate of silver, the precipitate being insoluble in nitric acid, but soluble in ammonia; by the production of two salts, a chloride and a nitrate, when an alkali is added to it; and by the evolution of binoxide of nitrogen on the addition of copper turnings.

PHYSIOLOGICAL EFFECTS.—It is a powerfully corrosive poison, acting in a similar manner to nitric acid.

USES.—It has been employed *internally* in the same cases as nitric acid, more especially in syphilis, diseases of the liver, and some of the exanthemata. *Externally* it has been used as a bath, either local or general, in syphilis and hepatic affections. Dr. Lendrick[1] has more recently noticed the utility of the general nitro-muriatic bath, at a temperature of 90° or 95°, in syphiloid and mercurial cachexiæ, and liver consumption. In India, the whole body (the head excepted) is immersed; but in this country pediluvia are usually employed, or the body is merely sponged with it.

ADMINISTRATION.—When taken internally, the dose is ten or fifteen drops properly diluted, and carefully increased.

ANTIDOTE.—Poisoning by this acid is to be treated in the same way as that by sulphuric acid.

BALNEUM NITRO-HYDROCHLORICUM; *The Nitro-Muriatic Bath.*[2]—This is prepared in narrow wooden tubs, by adding the acid to tepid water, until the latter becomes as sour to the taste as vinegar. Ainslie[3] says one ounce of acid is enough for a gallon of water. The patient should remain in the bath from 10 to 30 or 40 minutes. It excites tingling and prickling of the skin, and is said to affect the gums and salivary glands, causing plentiful ptyalism: indeed, we are told that, without the latter effect, every trial is to be regarded as inconclusive. In the passage of biliary calculi this bath is said to have proved remarkably effective.—Dr. Scott's *nitrous acid bath* was prepared by acidulating water with fuming nitric acid (Ainslie).

29. AMMONIA.—AMMONIA.

Formula NH^3. *Equivalent Weight* 17. *Equivalent Volume of the Gas* 2 or ☐

HISTORY.—It is probable that Pliny was acquainted with the smell of ammonia, and that the "vehement odour" which he says[4] arose from mixing lime with nitrum was produced by the action of lime on sal ammoniac. Dr. Black, in 1756, first pointed out the distinction between ammonia and its carbonate; and Dr. Priestley[5] first procured ammonia in a gaseous form. It is sometimes termed *volatile alkali*, and occasionally *azoturetted hydrogen* or *terhydruret of nitrogen.* Dr. Kane regards it as *hydramid* or *amidide of hydrogen.*

---

[1] *British and Foreign Medical Review*, vol. iv. p. 254.

[2] See Coyne's *Observations on the Aid obtained in various Diseases, particularly those incidental to Tropical Climates, by the External Application of the Nitro-muriatic Acid in a Bath*, Lond. 1822.

[3] *Materia Indica*, vol. ii. p. 340.

[4] *Historia Naturalis*, lib. xxxi. cap. 46, ed. Valp.

[5] *On Air*, vol. ii. p. 369, 1790.

NATURAL HISTORY.—Ammonia, free or combined, exists in both kingdoms of nature.

α. IN THE INORGANISED KINGDOM.—Hydrochlorate and sulphate of ammonia are met with native usually in the neighbourhood of volcanoes. Aluminous sulphate of ammonia (or ammonia alum) occurs in Bohemia. Dr. Marcet detected the hydrochlorate in sea water. This salt has also been recognised in mineral waters.[1] Ammonia exists in many of the native oxides of iron, and in most kinds of clay. Carbonate of ammonia is a constituent of the atmosphere, and is, therefore, found in rain water. Fresenius found the following proportions of ammonia in equal quantities of atmospheric air in the months of August and September.

By day	0·098	mean 0·133.[2]
By night	0·169	

β. IN THE ORGANISED KINGDOM.—Ammonia is found in vegetables in small quantities only. In the free state, it is said to exist in several plants, as *Chenopodium vulcaria, Sorbus aucuparia,*[3] in the juice of the leaves of *Isatis tinctoria,* in the bark of *Zanthoxylum Clava Herculis,* and in *Fucus vesiculosus.* Combined with carbonic acid, it is found in *Justicia purpurea;* with nitric acid, in the extract of hyoscyamus, distilled water of the lettuce, &c. In combination with different substances, it is found in the root of *Helleborus niger,* and of *Nymphæa;* in the leaves of *Aconitum Napellus;* in the barks of *Cusparia febrifuga* and *Simaruba*; and in the fruit of *Areca Catechu.*[4] Lastly, it is developed during the decomposition (spontaneous or artificial) of most vegetable substances—as gluten.

Ammonia is one of the bases found in the urine of man, where it exists in combination with phosphoric, hydrochloric, and uric acids. United to the last-mentioned acid, it exists in the excrement of the boa constrictor, and of some birds. The hydrochlorate is found in the dung of the camel. Ammonia is a product of the putrefaction of animal matters.

1. Gaseous Ammonia.

SYNONYMES.—This is commonly called *ammoniacal gas* (*gas ammoniacale*). Dr. Priestley denominated it *alkaline air.* It has also been termed *urinous air.*

PREPARATION.—Ammoniacal gas is obtained by heating a mixture of one part powdered sal ammoniac and two parts dry quicklime in a glass retort, and collecting the gas over mercury. In the absence of a mercurial apparatus, the gas may be generated in a Florence flask, to the mouth of which a straight glass tube is connected by means of a cork. The bottles which are to be filled with gas are to be inverted over the tube. To arrest the passage of water, a fold of blotting paper may be placed in the neck of the retort or in the glass tube.

If we regard sal ammoniac as hydrochlorate of ammonia, the reactions which occur in this process are as follows: One equivalent of hydrochlorate of ammonia is decomposed by one equivalent of lime; and the results of the decomposition are one equivalent of ammonia, one equivalent of chloride of calcium, and one equivalent of water. $NH^3,HCl+CaO=NH^3+HO+CaCl$.

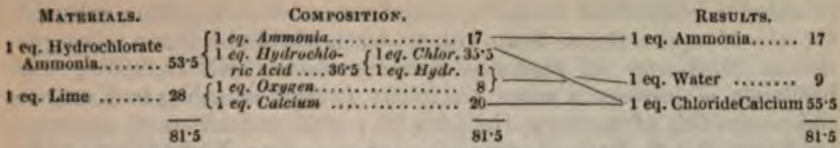
---

[1] Gairdner, *On Mineral Springs,* p. 15.

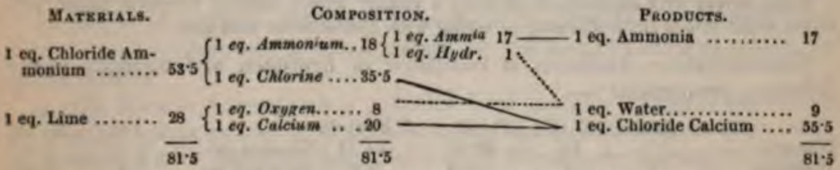
[2] *Ann. der Chem. und Pharm.* bd. lxxiv. S. 243.

[3] *Dict. des Drogues,* t. i. p. 293.

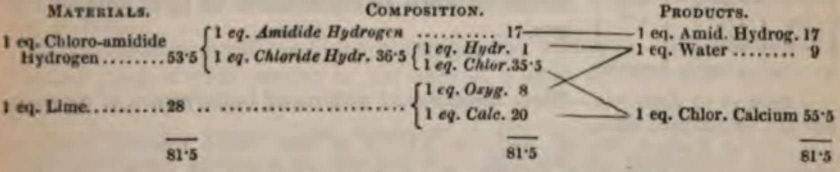
[4] De Candolle, *Physiol. Végét.* p. 339.


MATERIALS.
COMPOSITION.
RESULTS.
1 eq. Hydrochlorate Ammonia........ 53·5
1 eq. Ammonia................ 17
1 eq. Hydrochloric Acid .... 36·5
1 eq. Chlor. 35·5
1 eq. Hydr. 1
1 eq. Lime 28
1 eq. Oxygen.................. 8
1 eq. Calcium 20
1 eq. Ammonia...... 17
1 eq. Water 9
1 eq. ChlorideCalcium 55·5
81·5
81·5
81·5

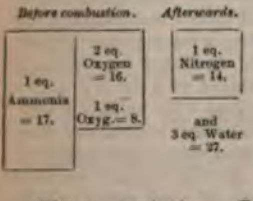
If, on the other hand, we consider sal ammoniac as a chloride of ammonium, the explanation is as follows: One equivalent of chloride of ammonium is decomposed by one equivalent of lime; and the products are one equivalent of ammonia, one of chloride of calcium, and one of water. $NH^4,Cl+CaO=NH^3+HO+CaCl$.



But, according to Dr. Kane, ammonia is an amidide of hydrogen, and sal ammoniac is a chloro-amidide of hydrogen; and the changes are thus explained: One equivalent of the chloro-amidide of hydrogen is decomposed by one of lime, the products being one of the amidide of hydrogen, one of water, and one of chloride of calcium, $HAd,HCl+CaO=HAd+HO+CaCl$.



PROPERTIES.—Ammonia is a colourless invisible gas, having a strong and well-known odour. It reddens turmeric paper, and changes the colour of violet juice to green; but by exposure to the air, or by application of heat, both the turmeric paper and violet juice are restored to their original colour. The specific gravity of this gas is 0·59. By a pressure of 6·5 atmospheres, at a temperature of 50°, it is condensed into a colourless, transparent liquid, whose sp. gr. is 0·731. One volume of this liquid expanded into 1009·8 vols. of ammoniacal gas at 60° F., barom. 30·2 inches. At −103° F., this liquid froze into a white translucent crystalline substance.[1]



Ammoniacal gas is not a supporter of combustion, but is slightly combustible in the atmosphere, and, when mixed with air or oxygen, it forms an explosive mixture. Every two volumes of it require one and a half volumes of oxygen for their complete combustion. The results of the explosion are, a volume of nitrogen and some water.

Characteristics.—It is readily recognised by its peculiar odour, by its action on turmeric paper, by its restoring the blue colour of reddened litmus paper, and by its forming white fumes with hydrochloric acid or chlorine. Dissolved in water, it communicates a deep blue colour to the salts of copper, throws down with the bichloride of platinum a yellow precipitate (*bichloride of platinum and ammonium*, $NH^4Cl,PtCl^2$); with bichloride of mercury a white precipitate (which, according to Kane, is a *chloro-amidide of mercury*, HgCl,HgAd); with protonitrate of mercury a black precipitate (*subnitrate of mercury and ammonium*, $NA^4O,3Hg^2O,NO^5$); and with a concentrated solution of tartaric acid, a crystalline precipitate (*bitartrate of the oxide of ammonium*, $NH^4O,HO,\overline{T}$).

---

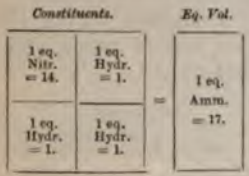
[1] Faraday, *Phil. Trans.* 1845.

The salts of ammonia evolve ammoniacal gas when heated with hydrate of lime or potash.

Conia agrees with ammonia in evolving a vapour which reddens turmeric paper, and forms white fumes (hydrochlorate of conia) with hydrochloric acid gas.

Composition.—Ammonia is composed of hydrogen and nitrogen in the following proportions:—

	Atoms.	*Eq. Wt.*	*Per Ct.*	*A. Berthollet.*		*Vol.*	*Sp. Gr.*
Nitrogen	1	14	82·35	81·13	Nitrogen gas	1	0·971
Hydrogen	3	3	17·65	18·87	Hydrogen gas	3	0·208
Ammonia	1	17	100·00	100·00	Ammoniacal Gas	2	0·590



The annexed diagram illustrates the volumes of the constituents of the gas, and their degree of condensation when in combination to form ammoniacal gas.

Theories of Ammonia.—Three theories exist with regard to the nature of ammonia and the ammoniacal salts.

1. *Old* or *Ammonia Theory.*—Ammonia, NH^3, is an alkali which combines with the hydracids to form ammoniacal hydrsalts, and with both water and the oxyacids to form the ammoniacal oxysalts. Sal ammoniac, or hydrochlorate of ammonia, NH^3,HCl, is an example of a hydrsalt; sulphate of ammonia, NH^3,HO,SO^3, of an oxysalt.

2. Berzelius's *Ammonium Theory.*—Ammonium, NH^4, is an hypothetical compound metal. Its oxide, NH^4O, is equal to an equivalent of ammonia, NH^3, and an equivalent of water, HO. Ammonium combines with the radical of the hydracids to form the ammoniacal hydrsalts, and with oxygen and an oxyacid to form the ammoniacal oxysalts. Sal ammoniac, or chloride of ammonium, NH^4,Cl, is an example of a hydrsalt; sulphate of the oxide of ammonium, NH^4O, SO^3, of an oxysalt.

3. Kane's *Amide Theory.*—Amide, or amidogen, $Ad=NH^2$, is an hypothetical substance. It combines with hydrogen to form the amidide of hydrogen or ammonia, $HAd=H,NH^2$, and with two atoms of hydrogen to form the subamidide of hydrogen or ammonium, $H^2Ad=H^2,NH^2$. Berzelius's oxide of ammonium, NH^4O, is a compound of the amidide of hydrogen and water, HAd,HO. The amidide of hydrogen (ammonia) combines with the hydracids to form the hydrsalts: thus with chloride of hydrogen (hydrochloric acid) to form sal ammoniac. $HAd+HCl=HAd,HCl$. It combines with the dry oxygen acids, but does not then form the proper ammoniacal salts: thus with sulphuric acid, $HAd+SO^3=HAdSO^3$. "It combines with a great number of saline bodies, and then resembles, in its functions, their water of crystallisation. Its most remarkable property, however, is, that in acting on metallic compounds, and on certain organic acids, it abandons an atom of hydrogen, and the remaining NH^2 combines with the metal or with the radical of the acid. Thus with HgCl and NH^3 there result $HgNH^2$ and HCl; with $PtCl^2$ and $2NH^3$ there are formed $Pt+2NH^2$ and 2HCl; from $HgNO^6$ and NH^3 are produced $HgNH^2$ and HNO^6. Of organic bodies, oxalate of ammonia gives, when heated, $C^2O^2+NH^2$, and benzoate of ammonia produces similarly $C^{14}H^5O^2+NH^2$."[1]

---

[1] Kane, *Elements of Chemistry*, p. 827; also, *Trans. of the Royal Irish Academy*, vol. xix. part i.

PHYSIOLOGICAL EFFECTS. α. *On Vegetables.*—Ammoniacal gas is destructive to plants, and changes their green colour to brown.[1]

β. *On Animals.*—If an animal be immersed in this gas, spasm of the glottis is immediately brought on, and death results from asphyxia (see *ante*, p. 117). Nysten[2] injected some of this gas into the veins of a dog: the animal cried out, respiration became difficult, and death soon took place. Neither gas nor visible lesion was observed in the heart, the two ventricles of which contained liquid blood. In another experiment he threw ammoniacal gas into the pleura of a dog: cries, evacuation of urine, and vomiting, immediately followed; soon afterwards convulsions came on, and continued for several hours: ultimately they ceased, and recovery took place.

In almost all cases of poisoning in animals, by ammonia or its carbonate, convulsions are observed, apparently showing that these substances act on the spinal marrow.

γ. *On Man.*—Ammonia is a powerful local irritant. This is proved by its pungent odour and its acrid and hot taste; by its irritating the eyes; and, when applied for a sufficient length of time to the skin, by causing vesication. If an attempt be made to inhale it in the pure form, spasm of the glottis comes on: when diluted with atmospheric air, it irritates the bronchial tubes and larynx, and, unless the quantity be very small, brings on inflammation of the lining membrane. Its chemical action is analogous to that of the alkalies in general (see *ante*, pp. 97 and 180-2). Its powerful action on the nervous system is best seen in cases of syncope (see *ante*, p. 230; also *Aqua Ammoniæ*).

USES.—Ammoniacal gas is rarely employed in medicine. M. Bourguet de Béziers used it with success in the case of a child affected with croup, to provoke the expulsion of the false membrane.

Mr. Smee[3] has proposed the inhalation of the vapour of a properly diluted liquor ammoniæ as a topical expectorant, to promote the secretion of a watery fluid from the mouth, fauces, trachea, and bronchi (see *ante*, p. 242). The apparatus he employs is similar to that used for the inhalation of chlorine (see *ante*, p. 384, figs. 66 and 67), except that the straight tube does not dip into the ammoniacal solution. He recommends this inhalation in what is called dryness of the throat from a deficiency in secretion, in chronic hoarseness, in chronic asthma, and to neutralise the poisonous effects of the vapour of bromine and hydrocyanic acid.

ANTIDOTE.—In case of the accidental inhalation of strong ammoniacal vapour, the patient should immediately inspire the vapour of acetic or hydrochloric acid. If bronchial inflammation supervene, of course it is to be treated in the usual way.

2. Aqua Ammoniæ.—Water of Ammonia.

SYNONYMES.—This solution is the *liquor ammoniæ* of the Pharmacopœia and shops, and which is sometimes called *aqua ammoniæ puræ* or *aqua ammoniæ causticæ*. It was formerly termed *spiritus salis ammoniaci*

---

[1] De Candolle, *Physiol. Vég.* p. 1344.
[2] *Recherches*, p. 140.
[3] *Lond. Med. Gaz.* April 7, 1843.

causticus cum calce viva paratus, or simply the *spirit of sal ammoniac* or *caustic spirit of sal ammoniac.*

PREPARATION.—It is prepared by the action of lime on either sulphate or hydrochlorate of ammonia. On the large scale, the apparatus employed is an iron cylinder, connected with the ordinary worm refrigerator, and this with a row of double-necked stoneware bottles containing water, analogous to those described under the head of Nitric Acid.

The *Edinburgh* and the *Dublin Colleges* give formulæ for the preparation of *liquor ammoniæ.* The *London College* places it among the articles of the materia medica, and appends a note for testing its efficiency, as follows:—

> "Colourless; specific gravity ·960; exposed to air it passes off in volatile acrid alkaline vapours, as shown by turmeric paper. It gives no precipitate with lime water; it is not coloured by the addition of hydrosulphuric acid; nor, when previously saturated with nitric acid, does it throw down anything on the addition either of sesquicarbonate of ammonia, nitrate of silver, or chloride of barium. About 10 grains of ammonia are contained in 100 grains."

The *London College* also gives a description of a stronger *liquor ammoniæ* (*liquor ammoniæ fortior*):—

> "The specific gravity of this is ·882. This can be reduced to the officinal standard by the addition of two ounces of distilled water to each ounce. About 30 grains of ammonia are contained in 100 grains."

The *Edinburgh College* gives the following directions for preparing *ammoniæ aqua,* sp. gr. 0·960, and *ammoniæ aqua fortior,* sp. gr. 0·880:—

> "Take of Muriate of Ammonia, thirteen ounces; Quicklime, thirteen ounces; Water, seven fluid-ounces and a half; Distilled Water, twelve fluidounces. Slake the Lime with the Water, cover it up till it cool, triturate it well and quickly with the Muriate of Ammonia previously in fine powder, and put the mixture into a glass retort, to which is attached a receiver with a safety-tube. Connect with the receiver a bottle also provided with a safety tube, and containing four ounces of the distilled water, but capable of holding twice as much. Connect this bottle with another loosely corked, and containing the remaining eight ounces of distilled water. The communicating tubes must descend to the bottom of the bottles at the further end from the retort; and the receiver and bottles must be kept cool by snow, ice, or a running stream of cold water. Apply to the retort a gradually-increasing heat till gas ceases to be evolved; remove the retort, cork up the aperture in the receiver where it was connected with the retort, and apply to the receiver a gentle and gradually-increasing heat, to drive over as much of the gas in the liquid contained in it, but as little of the water, as possible. Should the liquid in the last bottle not have the density of ·960, reduce it with some of the stronger Aqua Ammoniæ in the first bottle, or raise it with distilled water, so as to form Aqua Ammoniæ of the prescribed density."

The *Dublin College* gives directions for preparing two solutions of ammonia—*ammoniæ liquor,* and *ammoniæ liquor fortior.* The formulæ are as follows:—

> *Ammoniæ liquor.*—Take of Sal Ammoniac in fine powder, fresh-burned Lime, of each ℥viij.; Water, f℥iv.; Distilled Water, f℥xvj. The four ounces of water are used to slake the lime, which is next mixed with the sal ammoniac. This mixture is placed in a glass matrass or iron bottle, and the liquor distilled by a gentle heat into a Wolfe's apparatus containing the distilled water, and furnished with a mercurial safety-tube. The specific gravity is stated at ·950.
>
> *Ammoniæ liquor fortior.*—Apply heat to the mixture of Sal Ammoniac and Lime as above, and cause the gas to pass into f℥viij. of Ammoniæ Liquor, the temperature being kept down by water applied to the receiver.—Or, Pass the Ammoniacal Gas into f℥v. of Distilled Water, keeping the receiver cool. The specific gravity of this solution is ·900.

The theory of the process is the same as that for ammoniacal gas. An excess of lime is used to facilitate the extrication of the ammonia. The water put into the receiver is to absorb the gas.

PROPERTIES.—Solution of ammonia is a colourless liquid, having a very pungent odour and a caustic alkaline taste. Its action on turmeric paper and violet juice is like that of ammoniacal gas, before described. It is lighter than water, but its sp. gr. varies with its strength. The quantity of ammoniacal gas which water can dissolve, varies with the pressure of the atmosphere and the temperature of the water.

Davy[1] ascertained that at the temperature of 50°, under a pressure equal to 29·8 inches, water absorbs about 670 times its volume of gas, and becomes of sp. gr. 0·875. He drew up the following table, showing the quantity of ammonia in solutions of different specific gravities:—

100 parts of Sp. Gr.	Of Ammonia.	100 parts of Sp. Gr.	Of Ammonia.
0·8750 contain	32·50	0·9435 contain	14·53
0·8875	29·25	0·9476	13·46
0·9000	26·00	0·9513	12·40
0·9054	25·37	0·9545	11·56
0·9166	22·07	0·9573	10·82
0·9255	19·54	0·9597	10·17
0·9326	17·52	0·9619	9·60
0·9385	15·88	0·9692	9·50

It appears from the observations of Davy and Dalton that the specific gravity of mixtures of liquid ammonia and water is exactly the mean of that of the two ingredients.

Characteristics.—See *Ammoniacal Gas*, p. 435.

COMPOSITION.—Solution of ammonia consists of ammonia and water. The proportions vary with the sp. gr. of the liquids. Two solutions are officinal in this country,—*liquor ammoniæ* and *liquor ammoniæ fortior*.

1. *Liquor Ammoniæ*, Ph. L. E. D.; *Solution of Ammonia.*—The London and Edinburgh Colleges fix the sp. gr. of this solution at 0·960. A cubic inch of it consequently weighs 242·36 grains, and contains 132 cubic inches of ammoniacal gas. The Dublin College (1850) fixes the sp. gr. at 0·950. The following are about the strengths of these solutions, calculating from Davy's table:—

	Lond. and Edinb. Ph. (sp. gr. 0·960)	*Dub. Ph.* (sp. gr. 0·950)
Ammoniacal gas	10	12·75
Water	90	87·25
Liquor Ammoniæ	100	100·00

2. *Liquor Ammoniæ fortior*, Ph. Lond.; *Aqua Ammoniæ fortior*, Ph. Ed.; *Ammoniæ Liquor fortior*, Ph. Dubl.; *Stronger Solution of Ammonia.*—A strong solution of ammonia, under the above name, is kept in the shops for employment in smelling bottles, and for the preparation of irritating liniments or embrocations (see *Linimentum ammoniæ compositum*). The sp. gr. of the solution ordered by the Edinburgh College is 0·880, which is the strength of the liquid as prepared by the manufacturer. The London College fixes the sp. gr. at 0·882, and the Dublin at ·900. In a warm atmosphere, and especially when the bottle is frequently opened, or when the liquid is poured from one vessel to another, the gas

---

[1] *Elements of Chemical Philosophy*, p. 268.

higher

escapes rapidly from the liquid, whose sp. gr. is in consequence usually lower than that fixed by either of the Colleges. Dr. Christison says the sp. gr. of the commercial solution commonly ranges between 0·886 and 0·910. When mixed with water, the sp. gr. of the mixture is that of the mean: hence, if four volumes of liquor ammoniæ fortior, sp. gr. 0·880, be mixed with eight and a quarter volumes of distilled water, the sp. gr. of the mixture will be about 0·960: for $(0·880 \times 4) + (1·000 \times 8·25) \div 12·25 = 0·9608$. The weight of a cubic inch of liquor ammoniæ fortior, sp. gr. 0·880, is about 222·16 grains; that of sp. gr. 0·882 is 222·66 grains: the latter holds dissolved 360 cubic inches of ammoniacal gas.

The following are about the strengths of these solutions, calculating from Davy's table:—

	Edinb. Ph. (sp. gr. 0·880).		*Lond. Ph.* (sp gr. 0·882).
Ammoniacal gas.....................	31·2	....	30·5
Water..................................	68·8	....	69·5
Liquor Ammoniæ fortior	100·0	....	100·0

Purity.—A pure solution of ammonia has the characters attributed to it in the note of the London College (see *ante*, p. 438):—

Liquor ammoniæ frequently contains traces of carbonate of ammonia, which may be detected by lime-water or by a solution of the chloride of calcium, either of which occasions a white precipitate (*carbonate of lime*) if carbonic acid be present. When a portion of the liquid has been neutralised by pure carbonic acid, it ought not to cause a precipitate by the addition of nitrate of silver, of oxalic acid, or of sesquicarbonate of ammonia: for the first would indicate the presence of hydrochloric acid or chlorine; the second of lime; the third of lime or other earthy matter. If pure, it does not effervesce with dilute acids.

Dr. Maclagan[1] found some of the volatile ingredients of the liquor of gas-works in liquor ammoniæ. When an excess of nitric or sulphuric acid was added to the solution of ammonia, a red colouration, passing into purple, took place. When the ammonia was supersaturated with hydrochloric acid, and a clean shaving of fir-wood inserted in the fluid, it speedily became dyed of a rich purple, characteristic of pyrrol. Naphthaline was discovered by its odour and its crystalline-looking particles when a portion of the ammonia was supersaturated with sulphuric acid and submitted to distillation: the naphthaline was volatilised. The residue of the distillation, being mixed with a small quantity of caustic potash, evolved the odour of picoline. It is probable, therefore, that this liquor ammoniæ had been obtained by direct distillation from the ammoniacal liquor of gas-works, and not from the purified sulphate or muriate of ammonia.

Physiological Effects. α. *On Vegetables.*—The effects of ammonia on plants have been before noticed.

β. *On Animals.*—Orfila injected sixty grains of liquor ammoniæ into the jugular vein of a strong dog: tetanic stiffness immediately came on, the urine passed involuntarily, and the animal became agitated by convulsions: death took place in ten minutes. The body was immediately opened, when the contractile power of the muscles was found to be lost. In another experiment, thirty-six grains of concentrated solution of ammonia were introduced into the stomach, and the œsophagus tied: in five minutes the animal appeared insensible, but in a few moments after was able to walk when placed on his feet; the inspirations were deep, and his posterior extremities trembled. In twenty hours he was insensible, and in twenty-three hours he died. On dissection, the mucous membrane of the stomach was found red in some places. These experiments show the effects of large doses of this solution on the nervous system. The first experiment agrees in its results (that is, in causing tetanic convulsions) with that made by Nysten, and which has been before mentioned, of throwing ammoniacal gas into the cavity of the pleura. From the convulsions it may be inferred that in these instances the spinal marrow was specifically affected.

---

[1] *Monthly Journal of Medical Science*, June 1846.

γ. *On Man.* αα. *Local effects.*—In the concentrated form the local action of liquor ammoniæ is exceedingly energetic. Applied to the skin, it causes pain, redness, vesication, and destruction of the part; thus acting, first as a rubefacient, then as a vesicant, and lastly as a caustic or corrosive. Its emanations are also irritant: when they come in contact with the conjunctival membrane, a flow of tears is the result; when inhaled, their powerful action on the air-passages is well known. Persons in syncope are observed to be almost immediately raised from a death-like state merely by inhaling the vapour of this solution. In cases of insensibility it must be employed with great caution; for, if used injudiciously, serious or even fatal consequences may result. Nysten[1] tells us that a physician, for some years subject to epilepsy, was found by his servant in a fit. In order to rouse his master, the latter applied a handkerchief, moistened with this solution, to his nose so assiduously, that he brought on bronchitis, of which the patient died on the third day. In the *Edinburgh Medical and Surgical Journal* there is the report of the case of a lad whose death was produced, or at least hastened, by an attendant applying, "with such unwearied but destructive benevolence," ammonia to the nose, that suffocation had almost resulted. Dyspnœa, with severe pain in the throat, immediately succeeded, and death took place forty-eight hours afterwards. A French physician also suffered ulceration of the mouth and violent pulmonary catarrh in consequence of the excessive use of ammonia, given as an antidote for hydrocyanic acid. More recently another case of poisoning by the vapour of ammonia has been published.[2] It arose from the accidental bursting of a carboy of liquor ammoniæ. The mucous membrane of the nose and lips was destroyed. The tongue was deprived of its epithelium, and a large quantity of sanguineous froth escaped from the mouth. The respiration was so difficult, that suffocation was feared. The pulse was feeble, irregular, and frequent. There were no convulsions. Bronchitis supervened, but the patient recovered.

When the solution of ammonia is swallowed in large doses, it acts as a powerfully corrosive poison: but modern well-marked cases of poisoning by it in the human subject are wanting. However, it is very evident that violent inflammation of all that part of the alimentary canal with which the poison may be in contact, would be the result, and if much were taken, decomposition of the part might be expected. When swallowed in a very dilute form, and in small quantity, the local phenomena are not very marked, and the effect of the substance is then seen in the affection of the general system.

---

[1] Christison, *Treatise on Poisons.*

[2] *Journ. de Chim. Méd.* t. vi. p. 499, 2nde sér.

The chemical action of ammonia on the tissues is analogous to that of the other alkalies (see *ante*, p. 97).

ββ. *Remote effects.*—The remote effects may be investigated under two heads, according as they are produced by small or large doses. *In small* or *therapeutic doses*, such as we are accustomed to employ in the treatment of diseases, ammonia acts as a diffusible stimulant, excitant, or calefacient (see *ante*, p. 223). It produces a sensation of warmth in the mouth, throat, and epigastrium, frequently attended with eructations. A temporary excitement of the vascular system succeeds, but this quickly subsides. The heat of the skin is sometimes increased, and there is a tendency to sweating, which, if promoted by the use of warm diluents and clothing, frequently terminates in copious perspiration. But the skin is not the only secreting organ stimulated to increased exertion; we observe the kidneys produce more urine, and frequently the quantity of bronchial mucus is increased. The nervous system is also affected, and the activity of its functions heightened. Wibmer[1] made several experiments on himself, and found that ammonia affects the head, sometimes causing oppression or a sense of fulness, but no pain. The increased capability of muscular exertion, and the great facility with which all the functions are executed, are further indications of the action of ammonia on the nervous system.

There is, however, something remarkably different between the stimulant effects of ammonia and those of alcohol or opium. The first acts on the vascular system chiefly; the two latter on the cerebral system. The first has been termed by Dr. G. B. Wood[2] an arterial stimulant; the latter, cerebral stimulants. The first may be employed with great benefit in many inflammatory and febrile cases, in which the latter proves highly prejudicial. According to Dr. Billing,[3] ammonia is *not*, like wine and tincture of opium, a diffusible stimulant. "In the first place," he observes, "ammonia is used empirically, by the most able of the profession, in cases where they know from experience that they must not employ wine or tincture of opium. This alone shows that it is not really a diffusible stimulant—it is a local one; and as such, through the medium of the solar plexus, excites the heart momentarily, though not injuriously. Again, so far from being a diffusible stimulus, it immediately unites with animal acids, and then circulates, or is *diffused*, not as a stimulant, but as a *sedative* saline; so as to perform the double operation of a temporary local stimulant to the stomach and heart, and a sedative to inflamed capillaries elsewhere, although the latter indication be not contemplated in its administration."

The effects of large or poisonous doses on the human subject have not been described; but that the nervous system is affected, seems probable from a case mentioned by Plenck,[4] which terminated fatally in four minutes, though the symptoms are not related (see *Ammoniæ Sesquicarbonas*).

If we compare the effects of ammonia with those of other stimulants, as camphor, wine, and opium, we observe, in the first place, that the influence of ammonia is principally manifested in the ganglionic and true spinal systems,—while the other stimulants above mentioned affect the cerebral system. Thus the effects of ammonia are usually exhibited on the circulation, respiration, secretion, and spasmodic actions; but camphor, wine, and opium, though they also affect these functions, yet they principally affect the intellectual functions. Secondly, the effects of ammonia are more transient than those of the other agents just referred to. Thirdly, the vascular excitement caused by wine and opium is attended with diminished mucous secretion, and is allied more to an ordinary febrile attack.

---

[1] *Die Wirkung*, &c. Bd. i. S. 123.

[2] *Syllabus of a Course of Lectures on Materia Medica and Pharmacy*, Philadelphia, 1847.

[3] *First Principles of Medicine*, p. 158, 4th edit. Lond. 1841.

[4] *Toxicologia*, p. 226, ed. 2nda, Viennæ, 1801.

USES.—Ammonia is adapted for speedily rousing the action of the vascular and respiratory systems, and for the prompt alleviation of spasm. It is more especially fitted for fulfilling these indications when our object is at the same time to promote the action of the skin. It is calculated for states of debility with torpor or inactivity. It is also used as an antacid and local irritant.

1. *In dyspeptic complaints, accompanied with preternatural acidity of stomach and flatulence,* but without inflammation, a properly diluted solution of ammonia may be employed with a two-fold object—that of neutralising the free acid, and of stimulating the stomach. It must be remembered that the healthy secretions of the stomach are of an acid nature, and that the continued use of ammonia, or any other alkali, must ultimately be attended with injurious results, more especially to the digestive functions. While, therefore, the occasional employment of alkalies may be serviceable, their constant or long-continued use must ultimately prove deleterious.

Ammonia may, under some circumstances, be employed to neutralise acids introduced into the stomach from without, as in poisoning by the mineral acids; though chalk and magnesia would be more appropriate, being less irritant. It is a valuable antidote in poisoning by hydrocyanic acid. Its beneficial operation has been ascribed to the union of the alkali with the acid, whereby hydrocyanate of ammonia is formed; but since it has been found that this salt is highly poisonous, it is evident that this statement cannot be correct. Some have ascribed the activity of the hydrocyanate to its decomposition by the free acids of the stomach, and the consequent evolution of free hydrocyanic acid; but this explanation is not satisfactory. I believe the efficiency of ammonia as an antidote to poisoning by hydrocyanic acid, arises from its exerting an influence of an opposite nature to that of the poison. In poisoning by the oil of bitter almonds, or other agents supposed to contain this acid, ammonia is equally serviceable. The antidote should be given by the stomach, if the patient can swallow, and the vapour should be cautiously inhaled.

2. *To produce local irritation, rubefaction, vesication, or destruction of the part.*—As a *local agent,* ammonia has been employed in a variety of diseases—sometimes as a rubefacient or irritant, sometimes as a vesicant, and occasionally as a caustic. Thus it is employed as a rubefacient in rheumatic and neuralgic pains, and as a counter-irritant to relieve internal inflammations. As a local irritant, a weak solution has been injected into the vagina and uterus, to excite the catamenial discharge; but there are some objections to its use. Thus, it is a most unpleasant kind of remedy, especially to young females; moreover, the stoppage of this discharge is in many cases dependent on constitutional or remote causes, and therefore a topical remedy is not likely to be beneficial. Lavagna employed ten or fifteen drops of the solution, diluted with milk. The following is Nisato's formula:—

℞ Ammon. liquid. gtt. xl.; Decoct. Hordei, unc. viij.; Mucilag. Arab. unc. dimid. Misce, et fiant quatuor intra diem injectiones.

Sometimes ammonia is employed as a vesicatory; and it has two advantages over cantharides—a more speedy operation, and non-affection of the urinary organs. It may be employed either in the form of ointment or solution. As a caustic, the strong solution of ammonia may be sometimes used with advantage in the bites of rabid animals.

3. *The vapour of the solution of ammonia may be inhaled* when we wish to make a powerful impression on the nervous system—as in syncope, or to prevent an attack of epilepsy. To guard against or relieve fainting, ammoniacal inhalations are very powerful and useful: their instantaneous operation is frequently astonishing. Pinel says he once saw an attack of epilepsy prevented by this means. The patient (a watchmaker) had intimations of the approaching paroxysm from certain feelings; but he found, by inhaling the vapour of ammonia, it was frequently prevented. In the case of a confirmed epilepsy, which I was in the habit of watching for some years, I think I have also seen analogous beneficial effects. I speak doubtfully, because it is so difficult to determine, in most cases, the actual approach of the fit. It is deserving of especial notice, that ammonia is useful in three conditions of the system, which, though produced by very different causes, present analogous symptoms; viz. idiopathic epilepsy—the insensibility and convulsions (? epilepsy) produced by loss of blood—and the insensibility and convulsions (? epilepsy) which poisonous doses of hydrocyanic acid give rise to. (See *ante*, p. 218; also *Ammoniæ Sesquicarbonas*).

In asphyxia, ammoniacal inhalations have been strongly recommended by Sage, who says that he produced the apparent death of rabbits by immersion in water, and recovered them subsequently by the use of ammonia; and a case is mentioned of a man who had been submerged in the Seine for twenty minutes, and when taken out of the water appeared lifeless, yet by the use of ammonia recovered; and a M. Routier, a surgeon of Amiens, is said to have restored a patient in the same way. That it may sometimes be of service I can readily believe, but it must be employed with great caution.

The employment of the vapour of ammonia, by Mr. Smee, as a topical expectorant, has been already noticed (see *ante*, p. 437).

4. *Ammonia is given internally as a stimulant and sudorific* with manifest advantage in several cases, of which the following are illustrations:-

α. In continued fevers which have existed for some time, and where all violent action has subsided, and the brain does not appear much disordered, it is occasionally of great service. Its diaphoretic action should be promoted by diluents and warm clothing. It has an advantage over opium—that, if it do no good, it is less likely to do harm.

β. In intermittent fevers it is sometimes of advantage, given, during the cold stage, to hasten its subsidence.

γ. In the exanthemata, when the eruption has receded from the skin, and the extremities are cold, it is sometimes of great benefit, on account of its stimulant and diaphoretic properties. But in some of these cases the recession arises from, or is connected with, an inflammatory condition of the bronchial membrane, for which the usual treatment is to be adopted.

δ. In some inflammatory diseases (especially pneumonia and rheumatism), where the violence of the vascular action has been reduced by proper evacuations, and where the habit of the patient is unfavourable to the loss of blood, ammonia has been serviceable. In combination with decoction of senega, I have found it valuable in old pulmonary affections. (See *Senega.*)

5. *In certain affections of the nervous system,* ammonia is frequently employed with the greatest benefit. Thus it has been used to relieve the cerebral disorder of intoxication. In poisoning by those cerebro-spinants commonly termed sedatives—such as foxglove, tobacco, and hydrocyanic acid, ammonia is a most valuable agent. This remedy has been supposed to possess a specific influence in relieving those disorders of the nervous system accompanied with spasmodic or convulsive symptoms: and hence it is classed among the remedies denominated *antispasmodic.* Velsen, of Cleves, has used it with advantage in delirium tremens. It was a remedy frequently tried in the malignant or Indian cholera, and occasionally procured relief; but it was not much relied on.

6. *Against the bites of poisonous animals*—as serpents and insects—ammonia is frequently employed with the best effects. There does not appear, however, any ground for the assertion of Sage, that it is a specific; in fact, Fontana declares that it is sometimes hurtful in viper bites.[1]

ADMINISTRATION.—It is given in doses of from five to twenty or thirty drops, properly diluted.

ANTIDOTES.—The diluted acids—as vinegar, lemon- or orange-juice, &c.—are antidotes for ammonia. To abate the inflammatory symptoms caused by the inhalation of its vapour, blood-letting has been found serviceable.

1. LINIMENTUM AMMONIÆ, L. E. D.; *Liniment of Ammonia; Volatile Liniment; Oil and Hartshorn.* (Solution of Ammonia, f℥j.; Olive Oil, f℥ij. [f℥iij. *D.*] Mix and shake them well together.)—This is an ammoniacal soap composed of the oleo-margarate of ammonia mixed with some glycerine.[2] It is employed as an external stimulant and rubefacient, to relieve rheumatic and neuralgic pains, lumbago, sore-throat, sprains, bruises, &c.

2. LINIMENTUM AMMONIÆ COMPOSITUM, E.; *Compound Liniment of Ammonia.* (Stronger Aqua Ammoniæ [sp. gr. 0·880], f℥v.; Tincture of Camphor, f℥ij.; Spirit of Rosemary, f℥j. Mix them well together. This liniment may be also made weaker for some purposes, with three fluidounces of Tincture of Camphor and two of Spirit of Rosemary.)—These are obvious imitations of Dr. Granville's *counter-irritating* or *antidynous lotions.*[3] This liniment may be used so as to produce rubefaction, vesication, or cauterisation. A piece of linen six or seven times folded, or a piece of thick and coarse flannel impregnated with this liniment, is to be applied to the part and covered with a thick towel, which is to be firmly pressed against the part. If rubefaction merely be desired, the application is continued for from one to six or eight minutes; but from ten to twelve minutes are necessary to excite vesication and cauterisation. In painful and spasmodic affections, as neuralgia, cramp, &c.; in rheumatism, lumbago, and swollen and painful affections of the joints; in headache, sore throat, sprains, and many other cases, benefit may be obtained from a powerful and speedy counter-irritant like this, as stated by Dr. Granville.

---

[1] For some other uses of ammonia, see *Ammoniæ Sesquicarbonas.*

[2] See the articles *Soap* and *Olive Oil.*

[3] *Lancet,* Oct. 27, 1838; and *Brit. and For. Med. Rev.* vol. vii. p. 292. Also Dr. Granville's work, entitled *Counter-irritation, its Principles and Practice, illustrated by one hundred cases of the most painful and important diseases effectually cured by external applications,* Lond. 1838.

3. UNGUENTUM AMMONIÆ: *Liparolé d'Ammoniaque; Pommade Ammoniacale de Gondret; Gondret's Ammoniacal Ointment.*—The formula for this, as given by Soubeiran,[1] is as follows:—Suet, one part; Hog's Lard, one part; and Strong Solution of Ammonia, two parts. In Gondret's[2] work, however, the following formula is given:—Hog's Lard, ʒvij.; Oil of Sweet Almonds, ʒiss.; and Strong Liquid Ammonia, from ʒv. to ʒvj. Melt the lard, mix it with the oil, and pour them into a wide-mouthed bottle with a ground glass stopper; then add the ammonia, close the bottle, mix the contents together by shaking, and keep the mixture in a cool place.—This ointment, rubbed on the skin and covered by a compress, speedily produces vesication. Without the compress it causes rubefaction. It is a very useful rubefacient, vesicant, and counter-irritant.

4. TINCTURA AMMONIÆ COMPOSITA, L.; *Spiritus Ammoniæ succinatus.* (Mastic, ʒij.; Rectified Spirit, fʒix.; Oil of Lavender, ♏xiv.; Stronger Solution of Ammonia, Oj. Macerate the mastic in the spirit, that it may be dissolved, and pour off the clear tincture; then add the other ingredients, and shake them all together.)—This liquid is milky, owing to the separation of the mastic from its spirituous solution by ammonia. This preparation is an imitation of the liquid commonly called *Eau de Luce*[3] (*Aqua Luciæ*), after its inventor, who by some is said to have been an apothecary at Lille. M. B. Jussieu[4] gave it to one of his pupils who had been bitten by a viper; and, as the patient recovered, the remedy acquired considerable celebrity as a counter-poison to the bites of venomous snakes. But Fontana[5] has shown that ammonia (its active principle) does not possess any powers of this kind. The compound tincture of ammonia is a powerful antispasmodic stimulant, and is now principally employed as an antihysteric, in doses of from ten to thirty or forty minims. It has also been used as a stimulating embrocation. In angina pectoris it is also sometimes used as a stimulant and antispasmodic.

5. SPIRITUS AMMONIÆ, E.; *Spirit of Ammonia.* (Rectified Spirit, Oij.; Fresh-burnt Lime, ℥xij.; Muriate of Ammonia, in very fine powder, ℥viij.; Water, f℥viss. Let the lime be slaked with the water in an iron or earthenware vessel, and cover the vessel till the powder be cold; mix the lime and muriate of ammonia quickly and thoroughly in a mortar, and transfer the mixture at once into a glass retort; adapt to the retort a tube which passes nearly to the bottom of a bottle containing the rectified spirit; heat the retort in a sand-bath gradually, so long as anything passes over, preserving the bottle cool. The bottle should be large enough to contain one-half more than the spirit used.)—In this process we obtain, by the mutual reaction of the sal ammoniac and lime (see *ante,* pp. 434 and 435), ammoniacal gas, which passes over, and is dissolved in the spirit contained in the receiver. This preparation, which is a solution of caustic ammonia, is a more energetic solvent of resins and volatile oils, and a more powerful physiological agent, than its namesake, the *spiritus ammoniæ* of the London and Dublin Pharmacopœias, which is a solution of carbonate of ammonia. It is a stimulant antispasmodic. Doses ♏xxx. to fʒj.—The Edinburgh College directs it to be employed in the preparation of the *Spiritus Ammoniæ aromaticus, Spiritus Ammoniæ fœtidus, Tinctura Castorei ammoniata, Tinctura Guaiaci ammoniata, Tinctura Opii ammoniata,* and *Tinctura Valerianæ ammoniata.*

---

[1] *Nouveau Traité de Pharmacie*, t. ii. p 302, 2nde éd. Paris, 1840.

[2] *Traité Théorique et Pratique de la Dérivation contre les Affections les plus communes en géneral, telle la Pléthore, l'Inflammation, l'Hémorrhagie*, &c. Paris, 1837: reviewed in the *British and Foreign Medical Review*, vol. vii. p. 56.

[3] See the history of this preparation in Beckmann's *Hist. of Inventions and Discoveries*, vol. iv. p. 595, Lond. 1814. Beckmann says that Dossie, in his *Elaboratory laid open* (Lond. 1758), first gave a proper account of this preparation.

[4] *Histoire de l'Académie Royale des Sciences*, Anneé 1747, p. 54.

[5] *Treatise on the Venom of the Viper*, vol. ii. Lond. 1787.

30. AMMONIÆ CARBONATES.—CARBONATES OF AMMONIA.

HISTORY.—Both solid and liquid compounds of ammonia and carbonic acid have been known for several centuries. The manufacture of solid carbonate of ammonia has been probably long known to the Hindoos. Ainslie[1] gives a Tamool formula for its preparation by the sublimation of a mixture of sal ammoniac and chalk, but its date is unknown. The Arabians perhaps derived their knowledge of carbonate of ammonia from the Hindoos. Geber[2] speaks of *sal urinæ* "made of the calcined feces of the urine distilled." Raymond Lully, in the 13th century, was acquainted with the impure solution of carbonate of ammonia obtained from putrid urine; and it is probable that the Arabians had known it long before. Basil Valentine[3] speaks of the *spiritus salis urinæ.*

The real distinction between ammonia and its carbonate was pointed out by Dr. Black in 1756. Sir H. Davy[4] ascertained the existence of many varieties of carbonate of ammonia "containing very different proportions of carbonic acid, alkali, and water." His brother, Dr. J. Davy,[5] ascertained the existence of three definite compounds—viz. a carbonate, sesquicarbonate, and bicarbonate—and further, a hydrated carbonate. More recently Prof. Heinrich Rose[6] has described no less than twelve combinations, as follows:—

		Formulæ. (The carbonic acid is assumed to be combined with ammonia.)		
Neutral or *Mono-carbonate* ……	1. Neutral anhydrous carbonate……………………	NH_3	CO^2	
	2. Neutral hydrous carbonate ……………………	2NH	$2CO^2$	HO
$\frac{5}{4}$ *Carbonate* ……	3. $\frac{5}{4}$ Carbonate with 4 equivalents of water ………	$4NH^3$	$5CO^2$	4HO
	4. $\frac{5}{4}$ Carbonate with 5 equivalents of water ……	$4NH^3$	$5CO^2$	5HO
	5. $\frac{5}{4}$ Carbonate with 12 equivalents of water………	$4NH^3$	$5CO^2$	12HO
Sesquicarbonate ..	6. Sesquicarbonate (commercial) with 2 equivalents of water …………………………………	$2NH^3$	$3CO^2$	2HO
	7. Sesquicarbonate with 5 equivalents of water ……	$2NH^3$	$3CO^2$	5HO
$\frac{7}{4}$ *Carbonate* ……	8. $\frac{7}{4}$ Carbonate ………………………………………	$4NH^3$	$7CO^2$	12HO
Bicarbonate ……	9. Bicarbonate with 2 equivalents of water ………	NH^3	$2CO^2$	2HO
	10. Bicarbonate with $2\frac{1}{2}$ equivalents of water ………	$2NH^3$	$4CO^2$	5HO
	11. Bicarbonate with 3 equivalents of water…………	NH^3	$2CO^2$	3HO
$\frac{9}{4}$ *Carbonate* ……	12. $\frac{9}{4}$ Carbonate ………………………………………	$4NH^3$	$9CO^2$	10HO

---

[1] *Materia Indica,* vol. i. p. 367, 1826.

[2] *The Works of Geber,* p. 246, Lond. 1678.

[3] *Chymische Schriften,* Ander-Theile, S. 392, Hamb. 1677.

[4] *Researches, Chemical and Philosophical, chiefly concerning Nitrous Oxide,* 1800.

[5] *Edinburgh New Philosophical Journal* for April 1834.

[6] Poggendorff's *Annalen,* vol. xlvi. part 3; *also* Taylor's *Scientific Memoirs,* vol. ii. 1841.

NATURAL HISTORY (see *Ammonia*, p. 433).—Carbonate of ammonia is formed during the putrefaction or destructive distillation of those organic substances which contain nitrogen. It is a constituent of rain water.

PROPERTIES.—All the combinations of ammonia and carbonic acid are solids which have an ammoniacal odour; but the greater the quantity of carbonic acid they contain, the weaker is their odour. It is not perceptible at first in the recently prepared combinations with excess of carbonic acid, and not till they have been preserved in a vessel for some time unexposed to the air. The anhydrous carbonate may be volatilised unchanged; but all the combinations with more carbonic acid than contained in the neutral salt do not volatilise undecomposed (Rose).

Characteristics.—Volatilisible without residuum. When heated with water and a caustic alkali or earth, they evolve ammoniacal gas, the characters of which have been already stated (see *ante*, p. 434).

A solution of a carbonate of ammonia is distinguished from a solution of caustic ammonia by its effervescence with a dilute mineral acid, and by the white precipitates which it occasions with lime water, with chloride of barium, and with chloride of calcium.

The neutral or mono-carbonate of ammonia is distinguished from the other carbonates by the following circumstances: If the solution contain a neutral carbonate only, the whole of its carbonic acid is thrown down in combination with baryta by the addition of chloride of barium, and the liquor separated from the carbonate of baryta yields no further precipitate on the addition of pure liquid ammonia: but if the solution contain any super-carbonate of ammonia, a further precipitate takes place when pure liquid ammonia is subsequently added.

COMPOSITION.—Several of these combinations are perhaps double salts; especially the sesquicarbonate and $\frac{5}{4}$ carbonates, which are probably compounds of the anhydrous carbonate of ammonia, and either bicarbonate of the oxide of ammonium or bicarbonate of ammonia. If the $\frac{7}{4}$ carbonate and $\frac{9}{4}$ carbonate be also considered as double salts, of which the neutral anhydrous carbonate forms the one constituent, we are compelled to assume the existence of a quadricarbonate of the oxide of ammonium, or hydrous quadricarbonate of ammonia, a combination which has never yet been isolated. The $\frac{7}{4}$ carbonate will then consist of the anhydrous carbonate and the quadricarbonate; and the $\frac{9}{4}$ carbonate will be composed of the anhydrous carbonate, the bicarbonate, and the quadricarbonate.

The existence of an anhydrous carbonate of ammonia would appear to be a stumbling-block to Berzelius's ammonium theory. Rose, however, thinks that this theory is so plausible, and has justly been adopted by so many chemists, that the composition and properties of the anhydrous carbonate are insufficient to render the theory less possible. This carbonate, therefore, is regarded as a peculiar body, and has been sometimes termed *carbonate of hydramide* (HAd,CO^2). Dumas calls it *carbonamide* (Ad,CO,HO).

EFFECTS.—The effects of the carbonates of ammonia are similar to, but milder than, those of pure or caustic ammonia (see *ante*, p. 441); and they are milder in proportion as the quantity of carbonic acid they contain is greater. The neutral or mono-carbonate, therefore, is more powerful than the sesquicarbonate, and this than the bicarbonate.

1. Ammoniæ Monocarbonas.—Neutral Carbonate of Ammonia.

Formula $2NH^3,2CO^2,HO$; or (NH^3,CO^2+NH^4,O,CO^2). *Equivalent Weight* 87.

HISTORY.—Rose (see *ante*, p. 447) describes two neutral carbonates of ammonia, the one anhydrous, and the other hydrous. The former, however, appears to be an amide (see *ante*, p. 448). The latter, therefore, alone requires notice here. Rose terms it the *neutral hydrous carbonate of ammonia.*

PREPARATION.—Hydrated neutral carbonate of ammonia is the first, and, therefore, the most volatile, of the solid products which appear in the distillation of the commercial hydrated sesquicarbonate of ammonia. If the latter be digested in a small quantity of water, we obtain a solution of a neutral carbonate of ammonia, mixed, however, with a little of the bicarbonate. When the hydrated sesquicarbonate is distilled with alcohol, carbonic acid is evolved, and the neutral carbonate passes into the receiver along with the vapour of alcohol.

The same neutral carbonate is obtained when a mixture of sal ammoniac and carbonate of either soda or potash is submitted to distillation with water; and on this principle several officinal liquid preparations (presently to be mentioned) of the neutral carbonate are directed to be prepared. At the commencement of the distillation ammoniacal gas only escapes.

The *Dublin College* formerly ordered "equal parts of Muriate of Ammonia, pulverised and well dried, and dried Carbonate of Soda. Pass the mixture into an earthenware retort, and, with a heat gradually increased, sublime the carbonate of ammonia into a refrigerated receiver." They now, however, retain only a bicarbonate in their Pharmacopœia.

According to the old or ammonia theory, the following equation explains the changes which occur:—$2(NH^3HCl)+2(NaO,CO^2)=2NH^3,2CO^2,HO+2(NaCl)+HO$. But on the ammonium theory the equation is as follows:—$2(NH^4,Cl)+2(NaO,CO^2)=NH^3,CO^2+NH^4O,CO^2)+2(NaCl)+HO$.

Dr. Barker, in commenting on the preparation, formerly in the Dublin Pharmacopœia, states that "a product of greater whiteness and purity is obtained by carbonate of soda than by chalk as directed in the processes of the London and Edinburgh Colleges."[1] The fact is, its constitution is different.

PROPERTIES.—Hydrated neutral carbonate of ammonia is a crystalline salt, having an ammoniacal odour, but weaker than that of a solution of caustic ammonia. It is very volatile, and may be again sublimed without being essentially changed in its composition. According to Dr. John Davy it is a deliquescent salt, but Rose did not find it to be so.

Characteristics.—See *ante*, p. 448. Its solution yields, on the addition of chloride of barium, a white precipitate (*carbonate of baryta*): and no further precipitate is obtained by the further addition of caustic ammonia to the mixture. This character distinguishes the neutral carbonate from the super-carbonates of ammonia (see *ante*, p. 447).

COMPOSITION.—The hydrated neutral carbonate of ammonia has, according to Rose, the following composition:—

	Atoms.	*Eq. Wt.*	*Per Ct.*	*Rose.*
Ammonia	2	34	39·080	39·27
Carbonic Acid	2	44	50·575	50·09
Water	1	9	10·345	10·64
Neutral Hydrated Carbonate of Ammonia	1	87	100·000	100·00

	Atoms.	*Eq. Wt.*	*Per Ct.*
Carbonate of Ammonia	1	39	44·83
Carbonate of Oxide of Ammonium	1	48	55·17
	1	87	100·00

---

[1] Barker, *Observations on the Dublin Pharmacopœia.*

According to Rose, this salt is most probably a compound of the anhydrous carbonate of ammonia and carbonate of the oxide of ammonium.

PHYSIOLOGICAL EFFECTS.—See *ante*, p. 448. It is less powerful than caustic ammonia, but more so than the sesquicarbonate and bicarbonate.

USES.—In the solid state it is not employed in medicine. Several officinal liquids, however, owe their medicinal activity to it.

The solid neutral carbonate of ammonia is preferable to the sesquicarbonate for smelling bottles, as it does not lose its pungency by keeping. but as it evaporates it leaves the residue as good as ever: whereas the sesquicarbonate by exposure gives out its neutral carbonate, and becomes the bicarbonate, which has but little odour.—SYLVIUS'S SAL VOLATILE OLEOSUM was the neutral carbonate flavoured with volatile oils. It was prepared by submitting to distillation a mixture of sal ammoniac and carbonate of potash. Boerhaave gives a process for making an extemporaneous *sal volatile oleosum*, which he says was in great vogue in England in hysterical disorders.—MOUNSEY'S ORIGINAL PRESTON SMELLING SALTS are an obvious imitation of the preceding.—The PRESTON SALTS sold in the shops as a substitute are prepared extemporaneously by adding a few drops of liquor ammoniæ fortior and some volatile oils to coarsely powdered sesquicarbonate of ammonia.

1. SPIRITUS AMMONIÆ FŒTIDUS, L.E.D.; *Spiritus volatilis fœtidus*; *Fetid Spirit of Ammonia.*—In this, as in the preceding preparation, a difference exists in the formulæ of the British Colleges. The London College uses a solution of carbonate of ammonia, while the Edinburgh and Dublin Colleges employ a solution of caustic ammonia.

The formula of the *London College* is as follows:—Hydrochlorate of Ammonia, ℥x.; Carbonate of Potassa, ℥xvj.; Rectified Spirit, Water, of each Oiij.; Assafœtida, ℥v. Mix. Then distil Oiij. by a gentle heat. The specific gravity of this is ·861.

The *Dublin College* gives the following directions: Assafœtida, ℥iss.; Rectified Spirit, Oiss.; Stronger Solution of Ammonia, f℥iij. Break the Assafœtida into small pieces, and macerate it in the spirit for 24 hours; then distil off the entire of the spirit and mix the product with the solution of ammonia. The specific gravity of this preparation is ·849.

The *Edinburgh College* employs spirit of Ammonia (see *ante*, p. 446), f℥xss.; Assafœtida, ℥ss. Break the Assafœtida into small fragments; digest it in the spirit for twelve hours; and distil over ten fluid ounces by means of a vapour-bath heat.

This preparation is a very unnecessary one. It is merely a solution of the volatile oil of assafœtida in spirit of ammonia; for which a mixture of tincture of assafœtida and spirit of ammonia may be conveniently and more efficaciously substituted. It is a colourless, pungent, and fetid liquor, which becomes brownish by age. It is employed in hysteria in doses of from half a drachm to a drachm in water.

2. SPIRITUS AMMONIÆ AROMATICUS, L. E. D.; *Spiritus Salis Volatilis Oleosus*; *Spirit of Sal Volatile.*—The preparation of the London Pharmacopœia is a solution of the carbonate of ammonia; but that of the Edinburgh and Dublin Pharmacopœias contains caustic ammonia.

The *London College* gives the following formula:—Hydrochlorate of Ammonia, ℥vj.; Carbonate of Potash, ℥x.; Cinnamon, bruised; Cloves, bruised; of each, ʒijss.; Lemon Peel, ℥v.; Rectified Spirit; Water, of each, Oiv. Mix them, and let six pints distil.

In this process double decomposition takes place, as already noticed, and the carbonate of ammonia distils over with the spirit and part of the water flavoured by the essential oils of the aromatics used. The sp. gr. of this preparation is 0·918.

The *Dublin College* orders of Rectified Spirit, Oiij.; Stronger Solution of Ammonia, f℥vj.; Oil of Lemon, f℥ss.; Oil of Nutmeg, fʒij.; Oil of Cinnamon, fʒss. Dissolve the oils in the spirit, and add the solution of Ammonia; mix, with agitation, and filter. The specific gravity of this solution is ·852.

The *Edinburgh College* orders of Spirit of Ammonia (see *ante*, p. 446), f℥viij.; Volatile Oil of Lemon Peel, fʒj.; Volatile Oil of Rosemary, fʒiss. Dissolve the oils in the spirit by agitation.

This preparation, on account of its more agreeable taste and smell, is preferable to the spiritus ammoniæ carbonatis of former pharmacopœias, than which it is somewhat weaker. It is frequently employed in languor, fainting, hysteria, flatulent colic, and nervous debility, in doses of from fʒss. to fʒij. properly diluted with water. It is employed by the London College in the preparation of *Tinctura Guaiaci Composita*, and *Tinctura Valerianæ Composita*.

2. Ammoniæ Sesquicarbonas.—Sesquicarbonate of Ammonia.

Formula $2NH^3,3CO^2,2HO$; or $(NH^3,CO^2+NH^4,O,2CO^2+HO)$; or $(NH^4,O,CO^2+NH^4,O,2CO^2)$. *Equivalent Weight* 118.

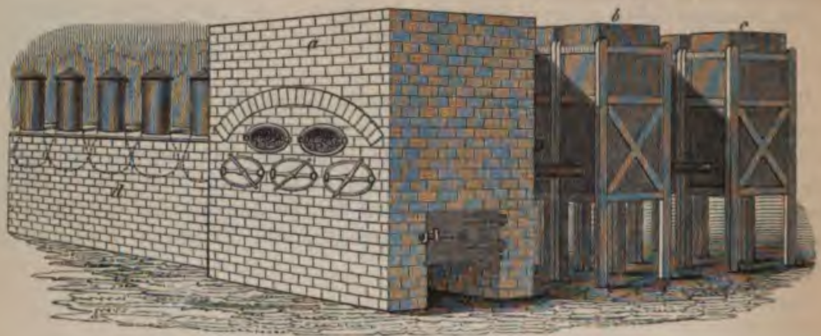
HISTORY.—This salt was probably known to Raymond Lully; but until late years it has been confounded with the other carbonates of ammonia. It is frequently denominated *subcarbonate of ammonia, carbonate of ammonia,* (*ammoniæ carbonas,* Ph. E.) *volatile or smelling salts,* or, *baker's salt.* The last appellation has been given to it because of its use by bakers as a substitute for yeast, in the manufacture of some of the finer kinds of bread.

It is probable that the terms *sal alkali volatile siccum* seu *urinosum, sal volatile salis ammoniaci,* and *sal volatile cornu cervi,* applied to this rather than to any other carbonate of ammonia.

PREPARATION.—Manufacturers prepare it by submitting to sublimation a mixture of sal ammoniac (or impure sulphate of ammonia) and chalk. In a manufactory which I inspected a few years since it was prepared as follows:—The retorts in which the sublimation was effected were of cast iron, and similar in shape and size to those employed in the manufacture of coal gas. Each retort communicated posteriorly with a leaden receiver, with which was connected a second receiver of the same size and shape. The receivers had the form of square prisms placed endways, and were supported in a wooden frame-work. In some manufactories they are cylindrical, and have movable tops and bottoms. The impure sesquicarbonate (*ammoniæ sesquicarbonas crudus*) thus obtained was contaminated with carbonaceous matter, which it deposited when dissolved in acids. It was refined in iron pots surmounted with leaden heads, and heated by the flue of the retort furnace. A little water was introduced into the pots to render the sesquicarbonate translucent. In another manufactory which I inspected, the pots were heated by a water-bath; a temperature of 150° F. being, I am informed, sufficient for this process. In this way *refined sesquicarbonate* (*ammoniæ sesquicarbonas rafinatus*) is obtained.

The *Edinburgh College* alone gives a formula for the preparation of this salt, ordering of Hydrochlorate of Ammonia, lb.j., and Chalk lb.jss. These are to be rubbed separately to powder, then mixed, and submitted to sublimation with a heat gradually increased.

FIG. 72.

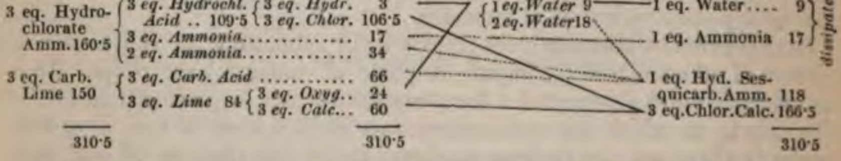


Manufacture of Sesquicarbonate of Ammonia.

a. Retort furnace. *b.* First leaden receiver. *c.* Second ditto. *d.* Refining pots.

In this process three equivalents of sal ammoniac react on three equivalents of carbonate of lime, and produce an equivalent of the hydrated sesquicarbonate of ammonia, three equivalents of chloride of calcium, one equivalent of ammonia, and one equivalent of water. The chloride of calcium is left in the retort, the hydrated sesquicarbonate of ammonia is sublimed, while the ammonia and the water are dissipated.

If we adopt the old or ammonia theory the equation is as follows:—$3(NH^3, HCl) + 3(CaO,CO^2) = 2NH^3,2HO,3CO^2 + 3CaCl + NH^3 + HO$.



It appears from experiments presently to be noticed that the compound called sesquicarbonate of ammonia is a double salt, consisting of one equivalent of carbonate and one equivalent of bicarbonate. Now in general, when two salts react on each other, the resulting compounds are also neutral; and, therefore, by the mutual action of 3 equivalents of hydrochlorate of ammonia and 3 equivalents of carbonate of lime, the calculated products should be three equivalents of hydrated neutral carbonate of ammonia (NH^3,CO^2, HO), called hypothetically carbonate of the oxide of ammonium (NH^4O,CO^2), and 3 equivalents of chloride of calcium ($CaCl$). But it appears from Rose's experiments that such a hydrated neutral carbonate of ammonia does not exist *per se*. Hence at the commencement of the heating process, ammoniacal gas escapes with just so much water as is sufficient to form the hypothetical oxide of ammonium.

If we regard the hydrated sesquicarbonate of ammonia as a double salt, the following equation will explain the reactions on the ammonium theory: $3\ (NH^4,Cl) + 3\ (CaO, CO^2) = NH^3,CO^2 + NH^4O,\ 2CO^2,\ HO) + 3\ CaCl + NH^3 + HO$.

According to Rose,[1] hydrated sesquicarbonate of ammonia cannot be re-sublimed unchanged. Hence, in the process of refining, its constitution changes; every two equivalents lose an equivalent of carbonic acid and the product is a hydrated $\frac{5}{4}$ carbonate of ammonia.

---

[1] Taylor's *Scientific Memoirs*, vol. ii.

MATERIAL.		COMPOSITION.		PRODUCTS.	
2 eq. Hydrated Sesqui-carb. Ammonia ..	236	*1 eq. Carbonic Acid.*	22	1 eq. Carbonic Acid	22
		5 eq. Carbonic Acid.	110	1 eq. Hydrated $\frac{5}{4}$ Carbonate of Ammonia ..	214
		4 eq. Ammonia	68		
		4 eq. Water	36		
	236		236		236

The *London College* gives the following note for ascertaining the qualities of the sesquicarbonate of ammonia of commerce.

> "Colourless, transparent, smells and tastes acrid; it changes turmeric paper to brown, dissipated by heat, soluble in water: nothing is thrown down either by chloride of barium or by nitrate of silver, nitric acid having been previously added to saturation."

PROPERTIES.—Hydrated sesquicarbonate of ammonia is met with in the form of fibrous, white, translucent cakes, about two inches thick. When exposed to the air it evolves carbonate of ammonia, and is converted into bicarbonate of ammonia; so that its vapour has a pungent odour, and strongly reddens turmeric paper. The resulting hydrated bicarbonate is opaque, pulverulent, and much less pungent, from which it has been termed *mild carbonate of ammonia.* The sesquicarbonate is soluble in four times its weight of cold water; but boiling water or alcohol decomposes it, with the evolution of carbonic acid.

Characteristics.—As an ammoniacal salt, this substance is recognised by its odour, its fugacious action on turmeric paper, and by its action on the salts of copper, bichloride of platinum, and bichloride of mercury (see the characteristics for ammonia, p. 436). As a carbonate it is known by its solution yielding a white precipitate (*carbonate of baryta*) with the chloride of barium: the clear liquor from which this precipitate has subsided yields a further precipitate on the addition of caustic ammonia. By this last character the sesquicarbonate is distinguished from the neutral carbonate. (See *ante*, p. 448.)

COMPOSITION.—This salt consists, according to Mr. Phillips,[1] Dr. J. Davy, Dr. Ure, and Rose, of carbonic acid, ammonia, and water, in the following proportions:—

							Rose.		
	At.	*Eq.Wt.*	*P.Ct.*	*R.Phillips.*	*J.Davy.*	*Ure.*	*(a)*	*(b)*	*(c)*
Carbonic Acid.......................	3	66	55·93	54·2	54·58	54·5	50·55	53·4	56·23
Ammonia..........................	2	34	28·81	29·3	27·39	30·5	28·66	30·7	
Water.............................	2	18	15·26	16·5	18·03	15·0	20·79	15·9	
Hydrated Sesquicarb. of Ammonia..	1	118	100·00	100·0	100·00	100·0	100·00	100·0	

Rose's analyses shew that the composition of this salt is not uniform. The differences in the results he explains by the modes of preparing the salt. "When it has been prepared directly by sublimation from carbonate of lime and sal ammoniac or sulphate of ammonia, then it is sesquicarbonate of ammonia. When, however, it has been once more sublimed in the manufactory, probably in order to purify it, it has changed into $\frac{4}{5}$ carbonate of ammonia." In the latter case its composition is as follows :—

---

[1] *Quarterly Journal of Science*, vol. vii. p. 294.

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Rose.*
Carbonic acid	5	110	51·40	51
Ammonia	4	68	31·78	31
Water	4	36	16·82	18
$\frac{5}{4}$ Carbonate of ammonia	1	214	100·00	100

Rose suggests that the commercial specimens which he found to be $\frac{5}{4}$ carbonate had been obtained by repeated sublimations, or possibly by one very slow sublimation.

It appears, however, from the observations of Dalton[1] and Scanlan,[2] that it is not a single salt or true sesquicarbonate, but a mixture or compound of the carbonate and bicarbonate; for if treated with a small quantity of cold water, a solution of carbonate is obtained, while a mass of bicarbonate having the form and dimensions of the sesquicarbonate employed, and of which it is a mere skeleton, is left. Two circumstances appear to me to prove that it is not a mere mixture, but a true chemical combination of these salts; viz. first the uniformity of its composition (when prepared in the same way), and secondly, its crystalline structure. Its constitution, then, is as follows :—

	At.	*Eq.Wt.*	*P.Ct.*
Anhydrous Carbonate of Ammonia	1	39	33·05
Hydrated Bicarbonate of Ammonia	1	79	66·95
Hydrated Sesquicarbonate of Ammonia	1	118	100·00

or

	At.	*Eq.Wt.*	*P.Ct.*
Anhydrous Carb. of Ammonia	1	39	33·05
Bicarbonate of the oxide of Ammonium	1	70	59·32
Water	1	9	7·63
Hydrated Sesquicarbonate of Ammonia	1	118	100·00

The formula $(NH^4O,CO^2+NH^4O,2CO^2)$ is less probable, because the anhydrous carbonate of ammonia is volatilized when the salt is exposed to the air; and also because the bicarbonate of oxide of ammonium always contains water.

IMPURITIES.—The hydrated sesquicarbonate of ammonia of commerce is sometimes contaminated with empyreumatic oil, and in this state it yields a more or less deeply-coloured, or even blackish, solution when dissolved in dilute acid. The pure salt, on the other hand, yields a colourless solution, and leaves no residuum when heated on platinum or glass. It is translucent and crystalline; but when exposed to the air it evolves anhydrous carbonate of ammonia, and becomes opaque, pulverulent, and less pungent: in this state it consists principally of bicarbonate of the oxide of ammonium. Lastly, its aqueous solution, saturated with pure nitric acid, gives no precipitate with solution either of chloride of barium or of nitrate of silver; for a precipitate with the first of these substances would indicate the presence of a sulphate, with the second a chloride. If any hyposulphite of ammonia be present, the salt, when neutralized by acetic acid, yields with the nitrate of silver a precipitate which is at first white, but becomes black. The presence of lead (derived from the leaden receivers used in its manufacture) is recognised by dissolving the salt in diluted nitric acid and testing with sulphuretted hydrogen, which produces a dark or black coloration or precipitate, if lead be present.

---

[1] *Memoirs of the Literary and Philosophical Society of Manchester*, 2d ser. vol. iii. p. 18.

[2] *Athenæum* for 1838, p. 596.

PHYSIOLOGICAL EFFECTS. α. *On Animals.*—The principal experimenters with this salt are Seybert, Orfila, and Gaspard, on dogs, and Wibmer on man. Seybert[1] injected in one experiment fifteen grains, in a second twenty-five grains, and in a third experiment forty-five grains of this salt, dissolved in a little water, into the crural vein of a dog: the animal appeared to suffer great pain; the frequency of the heart's action was increased, the respiration became difficult, and violent convulsions came on; but in all these cases perfect recovery took place. The blood drawn after the injection had its usual colour, odour, and consistence. Orfila[2] found that two drachms and a half of the salt, given to a dog, caused gastric inflammation, with tetanic convulsions; the body ultimately becoming curved, with the head forcibly bent backwards. Gaspard (quoted by Wibmer[3]) killed a young pig, of three weeks old, by injecting twenty-four drops of (a solution of) carbonate of ammonia in an ounce of water into the veins. Death occurred in nine hours.

β. *On Man.*—Wibmer found that a grain and a half of this salt produced on himself no remarkable effects; three grains increased the frequency of the pulse from 68 to 72 beats per minute, with throbbing headache. In other experiments in which he took from six to twelve grains (in some repeating the dose at short intervals), the effects were usually, but not constantly, increased frequency of pulse, with disorder of brain, manifested by the pain, heaviness, throbbing, &c. In one instance, he says, disposition to cough, and increased secretion of bronchial mucus, were remarkable. To an epileptic patient (a female) in the London Hospital, I gave fifteen grains of this salt three times a day for two months, without any apparent injury. The fits, which previously had occurred at stated periods, were suspended during the time the patient was under the influence of the medicine. I have repeatedly given a scruple of this salt three times daily for two or three weeks without any ill effect: on the contrary, with great benefit in hysterical and epileptical complaints. Huxham[4] has mentioned a remarkable case illustrative of the ill effects resulting from the long-continued use of this salt.

> "I had lately under my care," he observes, "a gentleman of fortune and family, who so habituated himself to the use of vast quantities of volatile salts, that at length he could eat them in a very astonishing manner, as other people eat sugar and caraway seeds. The consequence was that he brought on a hectic fever, vast hæmorrhages from the intestines, nose, and gums; every one of his teeth dropped out, and he could eat nothing solid; he wasted vastly in his flesh, and his muscles became as soft and flabby as those of a new-born infant; and he broke out all over his body in pustules. His urine was always excessively high coloured, turbid, and very fetid. He was at last persuaded to leave off this pernicious custom; but he had so effectually ruined his constitution, that, though he rubbed on in a miserable manner for several months, he died, and in the highest degree, of marasmus. And I am persuaded he would have died much sooner, had he not constantly drank very freely of the most fine and generous wines, and daily used large quantities of asses' milk, and anti-scorbutic juices, acidulated with juice of lemon."

The general action of this salt is similar to that of caustic ammonia, already noticed. Its topical operation, however, is less intense; for combination with carbonic acid diminishes the local action of ammonia in proportion to the quantity of acid present.

---

[1] Quoted by Wibmer, *Die Wirkung*, &c.

[2] *Toxicol. Générale.*

[3] *Die Wirkung*, &c.

[4] *Essay on Fever*, pp. 48 and 308, 3d edit. Lond. 1757.

In small doses it proves antacid, stimulant, and sudorific. By repeated use it operates as a resolvent or liquefacient spanæmic (see *ante*, p. 179), like the other alkalines (see *ante*, p. 180), though much less intensely so. In doses of thirty grains or more it is apt to occasion vomiting. The effects of an over-dose are abdominal pains, and other symptoms of inflammation, convulsions, and other phenomena indicative of its action on the nervous system.

Uses.—It is used in similar cases and under the same regulations as the solution of ammonia (see *ante*, p 443).

In *epilepsy* I have extensively employed it, and in many cases with obvious benefit. It should be given in large doses in properly diluted solutions: to adults from ten grains to a scruple. It frequently proves successful in hysterical epilepsy, and in that syncopal form of epilepsy which Sauvages called lipothymia, and which patients describe as "dying away," but the connection of which with ordinary epilepsy is shown by its occasional transition into the latter.

In *hysteria* also it is one of our most useful and valuable remedies; given either alone or in combination with a bitter infusion.

Recently this salt has been recommended, by Dr. Barlow,[1] in *diabetes*, several cases of which are said to have been relieved, if not cured, by it. I regret that I cannot confirm Dr. Barlow's favourable notice of it. Although in some cases I have seen patients temporarily improve under its use, yet the amendment has been brief, and was probably referable to other circumstances. In some cases no benefit whatever has attended its employment. In one case (that of a man, an out-patient at the London Hospital) it failed to give any relief, after a very prolonged trial.

It has been employed with excellent effect in some cases of *scrofula*.[2] It is best adapted for those cases attended with a languid circulation and a dry state of skin.

It has been recommended by Peyrilhe to relieve venereal pains and nodes.[3]

It is frequently employed for the preparation of effervescing draughts. The following are the relative proportions of acid and base to be used:—

20 grains of Sesquicarbonate of Ammonia require	6 fluidrachms of Lemon Juice, or
	24 grains of crystallised Citric Acid, or
	25½ grains of crystallised Tartaric Acid.

The citrate and tartrate of ammonia thus obtained are useful remedies in febrile cases, where the object is to promote cutaneous circulation and exhalation.

Full doses of this salt have been employed in *paralysis*, to occasion vomiting.

Mixed with some aromatic oil (as the oil of bergamot or lavender), it is used as a *smelling salt*, against syncope, hysteria, &c. (see *ante*, p. 450).

As a topical agent it has been employed in aqueous solution, or mixed with oil to form an imperfect kind of soap, or to make into ointment with lard. Its operation in these cases is that of a topical stimulant and rubefacient. It proves useful in rheumatic pains, sprains, &c.

---

[1] *Guy's Hospital Reports*, vol. v.

[2] *An Essay on Scrophula, in which an Account of the Effect of the Ammoniæ Carbonas, as a Remedy in that Disease, is submitted to the Profession*, by Charles Armstrong, M.D. Lond. 1812.

[3] Pearson's *Observations on the Effects of various Articles of the Materia Medica in the Cure of Lues Venerea*, Lond. 1800.

ADMINISTRATION.—As a stimulant and diaphoretic, it is used in doses of from five grains to a scruple. It is usually given in solution, but sometimes in the form of pill. As an emetic, the dose is thirty grains, properly diluted, and repeated if necessary.

ANTIDOTES.—See *Ammonia*, p. 445.

1. **LIQUOR AMMONIÆ SESQUICARBONATIS**, L.; *Ammoniæ Carbonatis Aqua*, E. (Sesquicarbonate of Ammonia. ℥iv. Distilled Water, Oj. Dissolve and filter).—By exposure to the air, this solution loses its pungency by the formation of bicarbonate of ammonia. It may be given internally in doses of from fʒss. to fʒiss., or even fʒij. properly diluted. It is a constituent of the following liniment:—

2. **LINIMENTUM AMMONIÆ SESQUICARBONATIS**, L.; *Liniment of Sesquicarbonate of Ammonia*. (Solution of Sesquicarbonate of Ammonia, f℥j.; Olive Oil, f℥iij. Shake them together until they are mixed).—Oil and sesquicarbonate of ammonia form a soap, but, owing to the presence of the carbonic acid, it is of an imperfect kind. Its effects and uses are analogous to the *Linimentum Ammoniæ* before mentioned (p. 445).

3. **AMMONIÆ SESQUICARBONAS PYRO-OLEOSA**; *Ammoniacum carbonicum pyro-oleosum*, Ph. Boruss.; *Sal Volatile Cornu Cervi*; *Empyreumatic Sesquicarbonate of Ammonia*: *Volatile Salt of Hartshorn*.—(Powdered Sesquicarbonate of Ammonia, ℥viij.; gradually add of Dippel's Oil, ʒij., carefully mix, and preserve the yellow powder in a well-stoppered bottle).—This is a substitute for the old salt of hartshorn. It is a very powerful stimulant and antispasmodic; and is employed in epilepsy, hysteria, asthma, typhus, paralysis, chronic rheumatism, &c. Dose gr. v. to gr. x. Usually given in solution; now and then in powder or pill.

3. Ammoniæ Bicarbonas.—Bicarbonate of Ammonia.

Formula $NH^{3},2CO^{2},2HO$; or $NH^{4}O,2CO^{2},HO$. *Equivalent Weight* 79.

HISTORY.—This salt was formed by Berthollet,[1] and hence it is sometimes termed *Berthollet's neutral carbonate of ammonia*. It is also called the *hydrated bicarbonate of the oxide of ammonium*.

PREPARATION.—The directions of the Dublin College for its preparation are as follows:—

> "Take of Commercial Sesquicarbonate of Ammonia any convenient quantity. Reduce it to a fine powder, and, having spread it on a sheet of paper, expose it to the air for twenty-four hours. Let it be now enclosed in a well-stopped bottle."

Bicarbonate of Ammonia is also formed by keeping the common sesquicarbonate of ammonia in imperfectly closed vessels. Another mode of obtaining it is by digesting water on the sesquicarbonate: the more soluble carbonate is dissolved, leaving the less soluble bicarbonate (see *ante*, p. 454).

---

[1] *Journ. de Physique*, Feb. 1807, p. 173.

Properties.—The crystals of this salt have, according to Rose, the same form as those of bicarbonate of potash. Their smell and taste are very faintly ammoniacal. By its faintly ammoniacal smell, Rose thinks that it indicates a tendency to pass into the $\frac{3}{4}$ carbonate. This salt is less soluble in water than the preceding carbonates ; for it requires eight parts of cold water to dissolve it. The solution, by exposure to the air, loses part of its carbonic acid, especially if it be heated.

Characteristics.—It is distinguished from the before-mentioned carbonates by having scarcely any ammoniacal odour.

Composition.—The composition of this salt is as follows :—

	At.	*E.Wt.*	*P.Ct.*	*Phillips.*	*Rose.*
Ammonia	1	17	21·5	21·16	21·39
Carbonic Acid	2	44	55·7	55·50	56·09
Water	2	18	22·8	23·34	22·52
Crystallised Bicarbonate of Ammonia	1	79	100·0	100·00	100·00

or

	At.	*E.Wt.*	*P.Ct.*
Oxide of Ammonium	1	26	33·0
Carbonic Acid	2	44	55·7
Water	1	9	11·3
Hydrated Bicarbonate of Ammonium	1	79	100·0

Rose has described two other bicarbonates of ammonia, one with two and a half, another with three atoms of water. The former ($NH^3,2CO^2, 2\frac{1}{2}HO$) is obtained by pouring as much boiling water over the common sesquicarbonate as is sufficient to dissolve this salt, and immediately covering the vessel to prevent the escape of carbonic acid. Large crystals of the bicarbonate are produced on the surface of the liquor on cooling. These Rose thinks have been mistaken for the bicarbonate with two atoms of water. They are distinguished by the form of the crystals (which are those of right rhombic prisms) and by the quantity of water which they contain.

Physiological Effects.—The effects of this salt are analogous to those of the preceding compounds of ammonia. It is diaphoretic, antispasmodic, and antacid. Being less caustic, it is more palatable than the other carbonates.

Uses.—It is employed in the same cases as the sesquicarbonate. It is sometimes used to form effervescing medicines. About 18 grs. of Citric, or 19 grs. of Tartaric acid, are required to saturate ℈j. of this salt.

Administration.—The dose of it is from ten grains to half a drachm dissolved in *cold* water.

31. AMMONIÆ HYDROCHLORAS.—HYDROCHLORATE OF AMMONIA.

Formula NH^3,HCl; or NH^4,Cl. *Equivalent Weight* 53·5.

History.—The early history of this salt is involved in considerable obscurity ; for though the term *sal ammoniacus* (ἅλς ἀμμωνιακός) is met with in several old writers, it is believed, by the erudite Beckmann[1] as well as by others, to refer to rock-salt. The first distinct notice of hydrochlorate of ammonia is to be met with in Geber, who was acquainted with the mode of purifying it by sublimation. But, as my friend Dr. Royle observes,[2] this salt must have been familiar to the Hindoos ever since they have burnt bricks, as they now do, with the manure of animals ; as some may usually be found crystallised at the unburnt extremity of the kiln."[3]

---

[1] *History of Inventions*, vol. iv. p. 306, Lond. 1814.

[2] *Essay on the Antiquity of Hindoo Medicine*, p. 41, Lond. 1837.

[3] [The muriate of ammonia forms an abundant white efflorescence, condensed in a crystalline

The substance, whatever its name may be, which the ancients termed sal ammoniac, derived its name from *Ammonia*, the name of a district of Libya where the oracle of Jupiter Ammon was situated. This district is usually said to have taken its name from ἄμμος, *sand*, on account of the sandy nature of its soil: but it is, perhaps, derived from ἄμμων, a word of Egyptian origin (see Liddell and Scott's *Greek Lexicon*). Herodotus[1] mentions the salt found in this district.

SYNONYMES.—Few substances have had so many synonymes as this salt.[2] Its most familiar names are, *sal ammoniac* or *muriate of ammonia* (*ammoniæ murias*). On the ammonium hypothesis it is called *chloride of ammonium*, while, according to Dr. Kane, it is the *chloro-amidide of hydrogen*.

NATURAL HISTORY.—See *Ammonia*, p. 433.

PREPARATION.—In Egypt, sal ammoniac is obtained by sublimation from the soot afforded by the combustion of camel's dung (*sal ammoniacus Ægyptiacus*).

It is probable that the muriatic acid or chlorine of this salt is derived from the common salt on which these animals feed; for Chaptal[4] says that he could only procure sal ammoniac from the soot of cow-dung and that of horses while these animals continued to live on marine plants.

Some years ago this salt was manufactured in London from the soot of coals. At the latter end of the last century it was made in Paris by the union of ammoniacal vapour (obtained by the decomposition of animal matters, in iron cylinders placed in a furnace) with muriatic acid gas.[5]

At Liege it is obtained by sublimation from the soot obtained by burning, in peculiar ovens, a mixture of coals, common salt, animal matter, and clay (L. Gmelin).

At the present time sal ammoniac is manufactured in this country from the impure ammoniacal liquors obtained as secondary products in the manufacture of coal gas and animal charcoal.

1. Manufacture of Sal Ammoniac from Coals.—In the manufacture of coal gas, coal is submitted to distillation in iron retorts, and the volatile matters obtained are conveyed to a condensing vessel or refrigeratory, in which are deposited tar and an ammoniacal liquor.

This ammoniacal liquor (commonly termed *gas liquor*) contains several salts of ammonia—such as carbonate, sulphate, hydrosulphate, &c. It is usually sold to sal-ammoniac manufacturers, who reside in the outskirts of the metropolis. The precise mode of proceeding, to convert it into sal ammoniac, varies according to circumstances. Sometimes sulphuric acid is added, and

---

powder, on the upper layer of bricks in most brick-kilns. We also found it in large quantity lining the interior of the crater of Mount Vesuvius.—ED.]

[1] Lib. iv. [*Melpomene*], cap. 181–2.

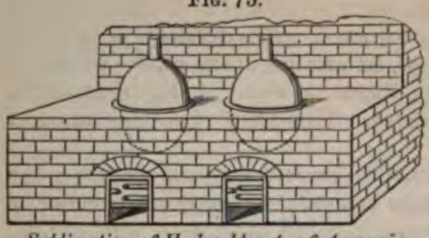
[2] For the alchymical names of this subject, see Dr. T. Thomson's *History of Chemistry*, vol. i. p. 121, Lond. 1830; and Parr's *Medical Dictionary*, art. *Ammoniacus*.

[3] A very full and complete description of the process, with illustrative plates, will be found in the splendid *Description de l'Egypte*, Etat Moderne, tom. i. page 413, Paris 1809; planches ii. and xxiv. Arts et Métiers. See also Parkes's *Chemical Essays*, 2d edit. vol. ii. p. 437, Lond. 1823.

[4] *Elements of Chemistry*, vol. i. p. 262, Lond. 1791.

[5] See *Journal de Physique for* 1794. Also Parkes, *op. supra cit.*

FIG. 73.

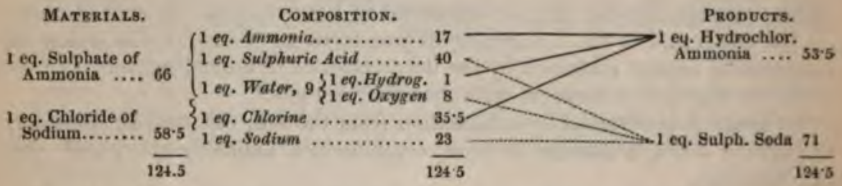


Sublimation of Hydrochlorate of Ammonia.

the liquor evaporated, by which brown crystals of sulphate of ammonia are obtained. This salt is then mixed with chloride of sodium, and submitted to distillation in iron pots lined with clay, to which are adapted leaden domes or heads, each having an aperture or open cylindrical tube, which can be closed or opened according to circumstances (fig. 73.)

A few years since, on examining the clay removed from the pots after the operation, I discovered small, but distinct and beautiful, crystals of the bisulphuret of iron, which had been formed during the process.

One equivalent of sulphate of ammonia reacts on one equivalent of chloride of sodium, and yields one equivalent of sal ammoniac, and one equivalent of sulphate of soda. On the old or ammonia theory, the equation is as follows: $HN^3,SO^3,HO + NaCl = NH^3,HCl + NaO,SO^3$.


MATERIALS.
COMPOSITION.
PRODUCTS.
1 eq. Sulphate of Ammonia 66
1 eq. Ammonia.............. 17
1 eq. Sulphuric Acid........ 40
1 eq. Water, 9
1 eq. Hydrog. 1
1 eq. Oxygen 8
1 eq. Chloride of Sodium........ 58·5
1 eq. Chlorine.............. 35·5
1 eq. Sodium 23
1 eq. Hydrochlor. Ammonia .... 53·5
1 eq. Sulph. Soda 71
124.5
124·5
124·5

On the ammonium theory, the equation is as follows:—$NH^4,O,SO^3 + NaCl = NH^4Cl + NaO,SO^3$. In some cases the gas liquor is saturated with hydrochloric acid, and the brown crystals of hydrochlorate of ammonia obtained by evaporation are purified by sublimation,

As a cheap substitute for hydrochloric acid, manufacturers sometimes employ an impure chloride of calcium.[1] This proceeding I have seen adopted at a manufactory on Bow Common; and the process has been described by my friend and former pupil, Dr. G. H. Jackson[2]: it is as follows:—

To the gas liquor, chloride of calcium is added, when a copious precipitation of carbonate of lime takes place, sal ammoniac being left in solution. The whole of this is put into a tub, having holes in the bottom to allow the solution to drain through, leaving the solid particles behind. This solution is evaporated at a gentle temperature in iron tanks, when it yields impure crystals of sal ammoniac, of a brownish colour. The salt is then dried, and the water of crystallisation driven off in a long iron vessel, very similar to a sand-bath. It is now placed in an iron subliming pot (previously coated to the extent of from one to five inches in thickness, with a composition of common clay, sand, and charcoal), capable of holding about 5 cwts. This is covered by a dome of lead, with an aperture at the top, in which a stopper is placed, by the removal and appearance of which the manufacturer judges of the progress of the sublimation. A gentle fire is kept up under the subliming pot for seven or eight days, when the dome having cooled down, and the sal ammoniac somewhat contracted, so as to loosen from the sides, the dome is thrown off from the iron pot, and about 2 or 3 cwts. of white, semi-transparent, sal ammoniac are knocked off in cakes.

---

[1] The chloride of calcium used in the above process is a secondary product, obtained, I am informed, from salt-works. It contains the chlorides of sodium and magnesium.

[2] *London Medical Gazette*, Aug. 4, 1839.

I have seen cakes of sal ammoniac, made at the same manufactory by this process, weighing between 5 and 6 cwts. each; and I am informed that they sometimes weigh 1000 lbs. each. They are discoloured on their convex surface (in contact with the leaden dome), and are, therefore, carefully scraped before being sent out.

The grey salt scraped from the exterior of the cakes consists of, or at least yields, hydrochloric acid, ammonia, and lead. A solution of the purified salt yields no iodide of lead on the addition of iodide of potassium, but affords a black precipitate (sulphuret of lead) when sulphuretted hydrogen gas is passed through it. It is probably a *double chloride of lead and ammonium.*[1]

Yellow or brownish streaks or bands are frequently observed in the cakes of sal ammoniac. These are ascribed by the manufacturers to the neglect of the workmen, who, falling asleep during the night, allow the fire to go down considerably, and then suddenly raise the heat, by which chloride of iron is sublimed in combination with sal ammoniac.

For several years I demonstrated in the lecture-room that a solution of these yellow bands in water gives no traces of iron on the addition of ferrocyanide of potassium, until a few drops of nitric acid be added, when a copious blue precipitate is formed; and I therefore inferred that this yellow matter was a *double chloride of iron and ammonium.* My opinion has been fully confirmed by the experiments of Dr. G. H. Jackson.

2. Manufacture of Sal Ammoniac from Bones.—Sal ammoniac is also manufactured from the ammoniacal liquor (called *bone spirit,*) obtained as a secondary product during the production of animal charcoal (see *ante,* p. 322).

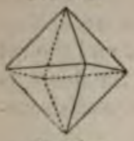
Manufacturers of animal charcoal usually sell their bone spirit to makers of sal ammoniac, who adopt different modes of proceeding, according to circumstances. Sometimes sal ammoniac is made from bone spirit in the same way as from gas liquor. Some manufactures digest the bone spirit with ground plaster of Paris (sulphate of lime), by which carbonate of lime and sulphate of ammonia are formed; the former is precipitated, the latter remains in solution. The liquid being filtered and evaporated yields brown crystals of sulphate of ammonia, which, being mixed with common salt, is submitted to sublimation, by which sulphate of soda and sal ammoniac are obtained.

PROPERTIES.—Hydrochlorate of ammonia usually occurs in commerce in the form of large hemispherical cakes which have a round hole in the centre, (*sal ammoniacus sublimatus*). They are translucent, and by exposure to the atmosphere become slightly moist. By solution or resublimation it may be obtained in regular octahedral, cubic, or plumose crystals, formed of rows

---

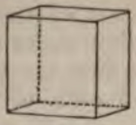
[1] Dr. Johnson, *London Medical Gazette,* Aug. 4, 1839.

FIG. 74.



Regular Octohedron.

FIG. 75.



Cube.

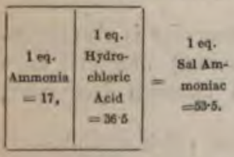
of minute octahedrons, attached by their extremities (*refined sal ammoniac*; *sal ammoniacus depuratus*; *flores salis ammoniaci*). The Brunswick sal ammoniac is in the form of sugar loaves. The sp. gr. of sal ammoniac is 1·450. Its taste is saline and acrid; it has no odour. When heated, it sublimes without undergoing fusion or decomposition. It is soluble in about 3 parts of cold and 1 of boiling water: cold being produced during the solution. It dissolves in alcohol.

Characteristics.—It may be recognised by the following characters: it is white and volatile; and if heated on the point of a knife by the flame of a candle, it readily sublimes. Mixed with caustic potash, or quicklime, it evolves ammoniacal gas, which is known by its odour, its action on turmeric paper, and its fuming with the vapour of hydrochloric acid. Dissolved in water, the hydrochlorate of ammonia produces, with a solution of nitrate of silver, a white precipitate of silver, recognised by the properties before described (see *ante*, p. 381); and with bichloride of platinum a yellow precipitate which, when collected, dried, and ignited, yields spongy platinum.

COMPOSITION.—The following is the composition of this salt on the old or ammonia theory:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Berzel.*	*Kirwan.*	*Bucholz.*		*Vol.*
Ammonia	1	17	31·78	31·95	25	31	Ammoniacal gas	2
Hydrochloric Acid	1	36·5	68·22	68·05	75	69	Hydrochloric Acid gas	2
Hydrochlorate Amm.	1	53·5	100·00	100·00	100	100		

If one equivalent or two volumes of hydrochloric acid gas be mixed with one equivalent or two volumes of ammoniacal gas combination is effected: the gases disappear, heat is evolved, and the white hydrochlorate is deposited.



According to Berzelius, sal ammoniac is *chloride of ammonium*, NH^4,Cl; while, according to Dr. Kane, it is a *chloro-amidide of hydrogen*. The composition of sal ammoniac, according to these hypothetical notions, is as follows:—

	Atoms.	*Eq. Wt.*	*Per Ct.*
Chlorine	1	35·5	66·35
Ammonium	1	18	33·65
Chloride of Ammonium	1	53·5	100·00

or

	Atoms.	*Eq. Wt.*	*Per Ct.*
Chloride of Hydrogen	1	36·5	68·22
Amidide of Hydrogen	1	17	31·78
Chloro-amidide of Hydrogen	1	53·5	100·00

IMPURITIES.—Hydrochlorate of ammonia is sometimes rendered impure by the presence of iron, or of lead: the modes of recognising which have been already pointed out.

PHYSIOLOGICAL EFFECTS. *a. On Vegetables.*—According to Sir H. Davy,[1] water holding in solution $\frac{1}{300}$th of its weight of hydrochlorate of ammonia promotes vegetation. Solutions which contained $\frac{1}{30}$th of their weight of this salt he found injurious.

---

[1] *Agricultural Chemistry.*

β. On Animals.—Courten,[1] Sprögel, Viborg, and Gaspard (quoted by Wibmer),[2] injected solutions of sal ammoniac into the veins of animals (dogs and horses): large doses generally caused convulsions, sometimes paralysis, and death. From the observations of Orfila, Smith, Arnold,[3] and Moiroud,[4] this salt appears to be a local irritant; and, when introduced into the stomach in large quantities, causes vomiting, purging, and gastro-enteritis. It exercises a specific influence over distant organs; for the first three of the above-mentioned experimenters observed that inflammation of the stomach ensued, to whatever part of the body the salt might have been applied, and the convulsions and paralysis above referred to attest its action on the nervous system. Arnold says it diminishes the plasticity of the blood.

γ. On Man.—Its local action is that of an irritant. Its chemical influence is not very obvious. It dissolves mucus, but does not coagulate albumen. Its action on the general system is that of a liquefacient and resolvent (see *ante*, p. 179), similar to that of the other neutral salts. Wibmer tried this salt on himself. He took from ten to twenty grains for a dose, which he repeated at the end of an hour. The effects were a sensation of warmth and oppression in the stomach, headache, and increased desire of passing the urine.

In this country it is so rarely employed internally that we have very slight experience either of its physiological or of its therapeutical effects. In Germany, where it is more frequently administered, it is in high repute as a powerful alterative or resolvent. "Like most salts," says Sundelin,[5] "sal ammoniac operates on the alimentary canal as an excito-irritant. After its absorption it appears to reduce moderately the action of the heart and large arteries, and, in this respect, belongs to debilitating or temperant agents. But it acts as excitant and irritant to the venous and arterial capillary systems, to the lymphatic vessels and glands, to the skin, to the kidneys, and especially to the mucous membranes; not only increasing secretion, but also improving nutrition and assimilation, and counteracting organic abnormal conditions (as tumors, thickenings, and relaxations), so frequently met with in those structures. It promotes not only the mucous secretions but also cutaneous exhalation, and even menstruation. Its diuretic effects are less obvious. It extends its stimulating influence to the serous and fibrous tissues, whose nutrition it improves.

"From these statements it follows that sal ammoniac operates like the more powerful alterative agents. In some respects it resembles mercury; but is less liquefacient and resolvent on the organic textures, and less stimulant to the lymphatic vessels, than the latter agent. Its long-continued use may, indeed, injure the digestive powers, but never gives rise to general cachexia. I have administered large doses of it against thickening of the mucous membrane, for months, without remarking any injurious effects beyond those just mentioned. In large doses it purges like other salts, but in small ones it rather constipates." Kraus[6] says that a slight miliary eruption and very painful aphthæ have been produced by large doses of it.

---

[1] *Phil Trans.* for 1712.

[2] *Die Wirkung*, &c.

[3] Wibmer, *op. cit.*

[4] *Pharmacol. Vétérinaire.*

[5] *Handbuch der speciellen Heilmittellehre*, 1er Bd. S. 150, 3te Aufl.

[6] *Heilmittellehre*, S. 309, Göttingen, 1831.

Uses.—In this country it is rarely employed internally. In Germany, where it is frequently used, it is administered in the following cases:—

1. *In mild inflammatory fevers,* especially those complicated with affections of the mucous or fibrous membranes, as in the diseases called bilious, gastric, catarrhal, or rheumatic fevers, it is employed for promoting secretion and hastening critical discharges.

2. *In inflammation of the mucous or serous membranes,* as catarrh, dysentery, urethritis, peritonitis, and pleuritis, when the first violence of the disease has been subdued, but when the secretions and exhalations are not yet established. In these cases it is used as a substitute for mercury.

3. *In chronic diseases* of various kinds, as chronic inflammation of the lungs, liver, and spleen; enlargement of the mesenteric glands; induration of the prostate, uterus, and ovaries; catarrhus vesicæ; chronic ulceration of the uterus; mucous discharges from the urethra and vagina,—it is administered as an alterative, as a stimulant to the absorbent system, and as a promoter of healthy secretion. [Mons. René Vanoye has exhibited large doses of the hydrochlorate of ammonia, with marked good effect, in cases of chronic enlargement of the prostate. He gives as much as fifteen grains, and even one drachm, every two hours. He has sometimes gradually increased this dose to upwards of two hundred grains with benefit.[1]—Ed.]

4. *In amenorrhœa* it is strongly recommended by Sundelin as an emmenagogue in those cases in which the disease depends on, or is connected with, inactivity of the uterus.

Externally it is sometimes employed, on account of the cold produced during its solution, in headache, inflammatory affections of the brain, mania, and apoplexy. When used for this purpose it must be applied as soon as the salt is dissolved. Mr. Walker[2] found that five parts of this salt, with five parts of nitrate of potash and sixteen parts of water, lowered the thermometer from 50° to 10° F. A *freezing mixture* of this kind placed in a bladder has been recommended by Sir A. Cooper as an application (*ice-poultice*) to hernial tumors. It may be applied to the head instead of the ice-cap, already noticed.

As a stimulant and resolvent, or discutient, sal ammoniac is used in the form of *plaster* or *lotion.* In powder it is sometimes employed as a dentifrice. A solution of ℥ss. in f℥xij. of water is used as a gargle. In these cases it is probably not better than common salt. It is occasionally used in pharmacy to augment the solubility of bichloride of mercury, with which it combines to form a soluble double salt (see *Liquor Hydrargyri Bichloridi*). Tobacconists use it in the manufacture of snuff.

Administration.—For internal use the dose of it is from five to thirty grains every two or three hours, either in a pulverulent form, combined with sugar or gum, or in solution with some saccharine or mucilaginous substance, to which an aromatic should be added.

Antidote.—When an overdose of this salt has been taken, warm water and mucilaginous and demulcent liquids should be given to promote vomiting. No chemical antidote or counterpoison is known. Gastro-enteritis is of course to be combated by the usual means.

---

[1] *Annales de Médécine de la Flandre française,* Avril 1852.

[2] *Phil. Trans.* 1801, p. 120.

1. LOTIO AMMONIÆ HYDROCHLORATIS; *Muriate of Ammonia Wash.*—A solution of sal ammoniac in water or in vinegar, with or without the addition of rectified spirit, is used as a resolvent or discutient lotion or embrocation. The proportions of the ingredients vary according to circumstances. When a strong lotion is required, from one to two ounces of the salt are dissolved in twelve fluidounces of liquid. Four ounces of rectified spirit are sometimes added. A wash of this strength is used in contusions and ecchymosis when there is no wound of the skin; in chronic tumors of the breast; in white swellings and other chronic affections of the joints; in hydrocele and dropsical enlargement of the thyroid gland; in chilblains; and in sphacelus after the requisite scarifications. Weaker solutions (as from ʒj. to ʒiv. of the salt in Oj. of water) are employed as washes in scabies and ulcers, and as injections in gonorrhœa and leucorrhœa.

2. EMPLASTRUM AMMONIÆ HYDROCHLORATIS; *Sal Ammoniac Plaster.* (Lead plaster, ℥ss.; Soap, ʒij.: melt them together, and when nearly cold, add Hydrochlorate of Ammonia, ʒss., in fine powder.)—This plaster is stimulant and rubefacient. Its efficacy depends on the evolution of ammoniacal gas, in consequence of the action of the alkali of the soap on the hydrochloric acid of the sal ammoniac: hence it requires renewal every twenty-four hours. It is employed as a discutient for chronic swellings, indurations, and white swellings. Dr. Paris[1] recommends it in rheumatism of the muscles of the chest, and in pulmonary complaints.

32. AMMONIÆ HYDROSULPHATES.—HYDROSULPHATES OF AMMONIA.

HISTORY.—Four ammoniacal compounds of sulphur and hydrogen are known. They are as follows:—

1. Hydrosulphate of ammonia or sulphuret of ammonium...	NH^3,HS or NH^4,S
2. Bihydrosulphuret of ammonia, or hydrosulphuret of the sulphuret of ammonium	$NH\ ,2HS$ or $NH^4,S+HS$
3. Pentasulphuret of ammonium	NH^3,HS,S^4 or NH^4,S^5
4. Heptasulphuret of ammonium	NH^3,HS,S^6 or NH^4,S^7

Besides the preceding, there is a fifth compound, commonly called *Boyle's fuming liquor of sulphur*, the precise composition of which is doubtful.

Of the preceding compounds, two only have been employed in medicine: these are the bihydrosulphate (commonly called hydrosulphuret of ammonia), and Boyle's fuming liquor of sulphur.

NATURAL HISTORY.—Privies, drains, sewers, and other receptacles of decomposing animal matter, evolve hydrosulphuret of ammonia along with sulphuretted hydrogen and nitrogen.

1. Ammoniæ Bihydrosulphas.—Bihydrosulphate of Ammonia.

HISTORY.—This is the compound which, under the name of *hepatized ammonia*, was employed by Dr. Rollo,[2] at the latter end of the last century, in the treatment of diabetes. Mr. Cruickshank[3] states that it was prepared by passing sulphuretted hydrogen gas through liquor ammoniæ until no farther absorption was perceived, or until the alkali was saturated. It is this compound to which the name of *hydrosulphuret of ammonia* (*ammoniæ hydrosulphuretum,* Ph. Dub.) is usually applied, and which is commonly employed as a test. It is sometimes called the *hydrosulphuret of the sulphuret of ammonium,* or the *sulpho-hydrate of ammonium,* or the *double sulphuret of ammonium and hydrogen.*

---

[1] *Pharmacologia.*

[1] *Cases of the Diabetes Mellitus*, 2d edit. Lond. 1798.

[2] *Ibid.* p. 52.

PREPARATION.—The crystallised salt is obtained by mixing equal measures of ammoniacal and sulphuretted hydrogen gases in a vessel surrounded by ice.—For medicinal and pharmaceutical purposes, an aqueous solution of this salt is employed. This is prepared by saturating liquor ammoniæ, diluted with three times its bulk of water, with hydrosulphuric acid (sulphuretted hydrogen) gas. The gas should be washed before it passes into the ammoniacal solution by passing it through water contained in a small bottle; otherwise a portion of the iron liquid is apt to pass over with the gas.

The following are the directions given in the last edition of the Pharmacopœia of the Dublin College for the preparation of this compound, under the name of *Ammoniæ Hydrosulphuretum*:—

Solution of Ammoniæ, four fluidounces; of Sulphuret of Iron, one ounce and a half; of Oil of Vitriol of Commerce, one fluidounce and a half; of Water, fifteen ounces; and of Distilled Water, two ounces. Place the sulphuret of iron and water in a two-necked bottle, and, adding the oil of vitriol by degrees through a safety funnel, conduct by suitable tubes the sulphuretted hydrogen which is disengaged, first through the distilled water placed in a small intermediate phial, and then to the bottom of a bottle containing the ammonia; the neck of the latter, through which the glass tube conveying the gas passes, being loosely plugged with tow. If, when the development of gas has ceased, a drop of the ammoniacal liquid added to a saturated solution of sulphate of magnesia gives no precipitate, the preparation is completed; but should a precipitate occur, the hydrosulphuric still contains free ammonia, and must therefore be again subjected to the action of a stream of sulphuretted hydrogen. The specific gravity of this solution is ·999.

The changes which attend the action of dilute sulphuric acid on sulphuret of iron have been already explained in the section on *Hydrosulphuric Acid.*

The hydrosulphuric acid gas, when conveyed into a solution of ammonia, combines with it to form the bihydrosulphuret of ammonia. $2HS+NH^3=NH^3,2HS$. According to the ammonium theory, the hydrosulphuret of the sulphuret or sulphide of ammonium is produced, $NH^4,S+HS$.[1]

When the solution of ammonia is completely saturated with sulphuretted hydrogen gas, it ceases to occasion a precipitate in a solution of sulphate of magnesia. If, however, it be incompletely saturated, it produces a precipitate with, or renders turbid a solution of, this salt. This is the test recommended by the Dublin College.

NEUTRAL HYDROSULPHURET OF AMMONIA; *Neutral sulphuret or sulphide of ammonium.*—If one portion of aqua ammoniæ be saturated with hydrosulphuric acid (sulphuretted hydrogen) gas, and then mixed with another and equal portion of aqua ammoniæ, we obtain the neutral hydrosulphate of ammonia. NH^3,HS; or NH^4,S.

PROPERTIES.—Solid bihydrosulphuret of ammonia occurs in acicular and foliated crystals, which have the combined odour of ammonia and sulphuretted hydrogen. They have an alkaline reaction, and are volatisable at ordinary temperatures. The officinal solution, commonly called the hydrosulphuret of ammonia, is a liquid having a very fetid odour and an acrid disagreeable taste. The mineral acids decompose it, and evolve hydrosulphuric acid gas. It forms with a considerable number of metallic solutions, precipitates. With the salts of lead, bismuth, silver, and copper, the precipitates are blackish; with those of antimony, red; with those of cadmium and tin (persalts), and with the arsenites (on the addition of an acid), yellow; lastly, with the salts of zinc, white. In these cases, the precipitates are either sulphurets or hydrated sulphurets of the respective metals. By keeping in bottles made of flint-glass, it gives rise to the formation of a thin coating of black sulphuret of lead on the inside of the bottle. [It should therefore be kept in a green glass bottle, or in one made of glass free from lead.—ED.]

---

[1] [The ammonium theory admits the existence of a monosulphuret, but it is wholly inconsistent with the existence of a bisulphuret of ammonium.—ED.]

Characteristics.—It is readily known to be a compound of sulphuretted hydrogen and ammonia by its odour. As a sulphuret or hydrosulphuret, it is known by its evolution of sulphuretted hydrogen when hydrochloric acid is added to it, and by its reactions on the metallic solutions already noticed. Its emanations blacken paper moistened with a solution of acetate of lead. Caustic potash causes the evolution of ammonia. The complete saturation of the ammonia with sulphuretted hydrogen is known by sulphate of magnesia, as already mentioned.

PURITY.—When badly prepared, bihydrosulphuret of ammonia sometimes deposits black flakes of sulphuret of iron. These must not be confounded with the black sulphuret of lead produced by the action of the bihydrosulphuret on the lead of the glass. They arise from a portion of the iron liquid being carried over into the ammoniacal solution along with the sulphuretted hydrogen, as already mentioned.

By exposure to the air, as by keeping in badly-stoppered bottles, or in bottles containing a small quantity of the liquid and a large quantity of air, the solution of the bihydrosulphuret of ammonia undergoes decomposition. It becomes yellow, ammonia is evolved, a deposit of sulphur takes place, and the pentasulphuret of ammonium (NH^4,S^5), or perhaps in some cases the heptasulphuret, of ammonium, is formed. The solution now, when supersaturated with hydrochloric acid, yields an abundant white precipitate of sulphur. The bihydrosulphuret, when long kept, yields a red precipitate with a solution of acetate of lead; a yellow one with a solution of emetic tartar; and a white one with a solution of arsenious acid. [It is in this state usefully employed for the absorption of the vapour of prussic acid, and thus serves as a most delicate test for the detection of this poison (see *Prussic Acid.*—ED.]

COMPOSITION.—Bihydrosulphate of ammonia has the following composition:—

	Ats.	Eq.Wt.	P.Ct.		Ats.	Eq.Wt.	P.Ct.		Vols.
Hydrosulphuric Acid	2	34	66·66	Sulphuret of Hydrogen	1	17	33·33	Hydrosulph. Acid Gas	2
Ammonia	1	17	33·33	Sulphuret of Ammonium	1	34	66·66	Ammoniacal Gas	2
Bihydrosulphate of Ammonia........	1	51	100·00	Sulph. of Hydrogen and Ammonium..	1	51	100·00		4

PHYSIOLOGICAL EFFECTS. α. *On Vegetables.*—The vapour of this compound is injurious to vegetation.

β. *On Animals.*—I am unacquainted with any experiments made with it on animals; but analogy leads us to believe that its action is that of a powerful poison, analogous to that of other alkaline sulphurets and of hydrosulphuric acid.

γ. *On Man.*—In *small* but *repeated doses* it acts powerfully on the secreting organs, the action of which it promotes, but at the same time modifies. Its principal influence is directed to the skin (on which it operates as a sudorific) and to the pulmonary mucous membrane. In *somewhat larger doses* it occasions nausea and giddiness. In *still larger doses* it causes nausea, vomiting, diminished frequency of pulse, giddiness, extreme languor, drowsiness, and sleep. *Excessive doses* would, of course, produce death, though I am unacquainted with any case of this kind.

In the gaseous state it acts, when inhaled, as a powerfully asphyxiating agent. Instances of its deleterious operation, in conjunction with hydrosulphuric acid, have occurred in France among workmen exposed to the vapours from the pits (cesspools) of the necessaries. The symptoms are—sudden weakness, insensibility, and death; or when the vapours are less concentrated, there are sometimes delirium and convulsions.

Uses.—In this country it has been principally employed in *diabetes mellitus*, with the view of reducing the morbid appetite and increased action of the stomach, as well as of the system in general.[1] It has also been used in old pulmonary catarrhs, and, by Brauw and Gruithuisen, in vesical catarrh.[2]

Administration.—It is given in doses of from four to six drops in some proper vehicle (distilled water is the best) three or four times a day. Dr. Rollo recommended that the dose should be increased so as to produce slight giddiness. It is, however, a dangerous medicine, and requires great caution in its use. On account of its speedy decomposition, it should be dropped from the bottle at the time of using it.

Antidotes.—The antidotes for hydrosulphate of ammonia, as well as for hydrosulphuric acid, are chlorine and the chlorides of lime and soda. In cases of asphyxia by the inhalation of the hydrosulphate, the treatment consists in placing the patient on his back in the open air, with his head somewhat elevated; and if the body be warm, in applying cold affusion to the back, face, and breast; producing artificial respiration of air (through which chlorine is diffused) by pressing down the ribs and forcing up the diaphragm, and then suddenly removing the pressure; using strong friction in the course of the vertebral column, chest, and soles of the feet, and injecting into the stomach stimulants, as a weak solution of chlorine (or of chloride of lime) or brandy, &c. In the event of hydrosulphuret of ammonium being by accident swallowed in poisonous doses, dilute solutions of chlorine, or of the chloride of lime and soda, should be immediately given, and the contents of the stomach removed by the stomach-pump as soon as possible.

2. Boyle's Fuming Liquor of Sulphur.

History.—Beguin[3] described the method of preparing this compound, which he called *oil of sulphur* (*oleum sulphuris*). Boyle,[1] who also gives directions for its preparation, called it *volatile tincture of sulphur*, and says that it "may probably prove an excellent medicine." F. Hoffman[2] refers to Beguin's work, and also gives a formula for its preparation. He calls it *tinctura sulphuris volatilis sive spiritus salis ammoniaci sulphureus, aurei coloris*. He also refers to it under the name of *spiritus sulphuris volatilis*. It is commonly called *Beguin's volatile spirit of sulphur* or *Boyle's fuming liquor* (*liquor fumans Boylii*), though I cannot find that either of these authors called it by these names. It is the *volatile liver of sulphur* (*hepar sulphuris volatile*) of some writers.

---

[1] Rollo, on *Diabetes Mellitus*, p. 28, 2d edit.

[2] Vogt, *Pharmacodynamik*.

[3] *Tyrocinium Chymicum*, p. 180, Wittebergæ, 1650. Also the English translation of this work, p. 65, Lond. 1669.

Its proper chemical name is at present doubtful.

PREPARATION.—It is obtained by submitting to distillation a mixture of sulphur, sal ammoniac, and lime. Beguin orders one pound of sulphur, half a pound of quicklime, and four ounces of sal ammoniac. Boyle directs five ounces of sulphur, five ounces of sal ammoniac, and six ounces of quicklime. Later writers order one part of sulphur, two of sal ammoniac, and two, three, or four parts of slacked lime. Some employ in addition three parts of water in the receiver; but no water is mentioned in the original formulæ of Beguin and Boyle.

Liebig says it may be procured by shaking the hydrosulphate of ammonia with sulphur as long as the latter is dissolved. The clear liquor is then to be poured off the excess of sulphur.

The composition of this liquid being doubtful, it is obvious that the explanations of the reactions which occur cannot be precise. At the commencement of the process ammonia is evolved. This arises from the mutual reaction of lime and sal ammoniac. $NH^3,HCl+CaO=NH^3+CaCl+HO$. No ammonia is decomposed during the operation. The sulphur takes hydrogen from the hydrochloric acid, and with ammonia forms the fuming liquor. The residue in the retort after the operation is a mixture of chloride of calcium, sulphuret of calcium, and sulphate of lime. L. Gmelin gives the following equation as illustrative of the changes: $4CaO+3(NH^3,HCl)+16S=3CaCl+CaO,SO^3+3(NH^3,HS^5)$.

PROPERTIES.—An orange-yellow coloured liquid, having an oily consistence. It fumes in the air and in oxygen gas, but not in hydrogen or nitrogen. This fuming property does not depend, as in the case of the strong mineral acids, on the attraction of atmospheric humidity, but on the oxidation of the volatile compound and the formation of hyposulphite of ammonia in the form of a fine crystalline powder.

Characteristics.—It is characterised by its fuming property, by its odour (that of sulphuretted hydrogen and ammonia), and by its colour. The deeper its yellow colour, the better is its quality reckoned. When decomposed by excess of hydrochloric acid, it gives out sulphuretted hydrogen gas, and lets fall a white precipitate of sulphur. It is entirely volatilised by heat.

COMPOSITION.—Its composition has not been very accurately ascertained. Berthollet[3] considered that it was a hydrosulphuret of ammonia with excess of ammonia, and Mr. Graham regards it as a protosulphuret of ammonium

---

[1] *Experimental History of Colours*, part. iii. exp. xxxiv. (Boyle's *Works*, vol. ii. p. 59, Lond. 1754.)

[2] *Observationem Physic.-Chymic.* lib. ii. observ. xxxi. (*Opera omnia*, t. iv. p. 514, Genevæ, 1748.)

[3] *Ann. de Chimie*, t. xxv. p. 24.

(NH^4,S). Gay-Lussac,[1] however, considered it to be a compound of hydrosulphate of ammonia with several atoms of sulphur. L. Gmelin says that it is perhaps a watery mixture of hydrosulphate of ammonia and pentasulphuret of ammonium. Brande calls it persulphuret of ammonia.

EFFECTS.—Similar to those of bihydrosulphate of ammonia (see *ante*, p. 466).

USES.—Beguin says that it is very useful for wounds and ulcers. F. Hoffmann employed it in combination with rectified spirit of wine under the name of *liquor antipodagricus*. This consisted of one part of the fuming liquor and three parts of rectified spirit. He gave it in doses of thirty or forty drops as a powerful sudorific, and applied it, mixed with camphor, to the affected parts, and says that it relieved pain like a charm.

33. Ammoniæ Sulphas.—Sulphate of Ammonia.

Formula NH^3,SO^3,HO; or NH^4O,SO^3. *Equivalent Weight* 66.

Sulphate of the oxide of ammonium; Oxysulphide of ammonium; Glauber's secret sal ammoniac (*sal ammoniacum secretum Glauberi*).—This salt is found native, in the neighbourhood of volcanoes, under the name of *mascagnine*. It is a constituent of soot from coals. It is usually obtained by dissolving hydrated sesquicarbonate of ammonia in diluted sulphuric acid to saturation, and evaporating so that crystals may form as the solution cools. In an impure state it is procured by saturating the ammoniacal liquor of gas-works or bone spirit with sulphuric acid; and the sulphate thus obtained is used in the preparation of sal ammoniac. Sulphate of ammonia, when crystallized $(NH^3,SO^3,2HO)$, contains two equivalents of water; of one of which it may be deprived by heat. Anhydrous sulphate of ammonia does not appear to exist; for when anhydrous sulphuric acid and ammoniacal gas are combined, a compound is formed in which neither sulphuric acid nor ammonia are evident to the usual tests. Its composition is supposed to be NH^2,SO^2+HO; and it has been denominated *sulfamide*. Sulphate of ammonia was formerly employed as a stimulant, resolvent, and diuretic. Dose, ℈j. to ʒss.—It serves for the preparation of sal ammoniac and sesquicarbonate of ammonia (see *ante*, pp. 451 and 459.)

The *spiritus cornu cervi rectificatus*, completely saturated with sulphuric acid, was formerly employed in medicine under the name of *liquor anixii*.[2] The dose was 60 drops.

[Mr. Spence, of Manchester, has patented a process for the manufacture of this salt, which consists in the arrangement of a series of boilers containing hot water, into each of which ammoniacal gas is passed successively until saturation has taken place. The sulphuric or hydrochloric acid is then passed into the saturated ammoniacal solution, and the liquor acquires such a sp. gr. that crystallization takes place on cooling, thereby saving the expense of fuel for evaporation.[3]—ED.]

34. Ammoniæ Nitras.—Nitrate of Ammonia.

Formula NH^3,NO^5,HO; or NH^4,O,NO^5. *Equivalent Weight* 80.

Nitrate of the oxide of ammonium; Nitrum semivolatile; Nitrum flammans.—This salt is obtained by saturating diluted nitric acid with sesquicarbonate of ammonia, and evaporating so that crystals may form when the solution cools. If the solution be evaporated at a temperature below 100° F., large and beautiful six-sided prisms are obtained, terminated by six-sided pyramids *(prismatic nitrate of ammonia)*. These crystals belong to the right prismatic system, and are isomorphous with nitrate of potash. They consist of one equivalent of nitric acid 54, one equivalent of ammonia 17, and one equivalent of water 9. If the solution be boiled down, fibrous crystals are obtained *(fibrous nitrate of ammonia.)*

---

[1] *Cours de Chimie*, t. ii. 20me Leçon, 1828.

[2] Richter's *Ausfuhrliche Arznemiittellehre*, Bd. iv. p. 222.

[3] *Pharmaceutical Journal*, 1851, p. 607.

When dried at 300° F., nitrate of ammonia assumes the form of a compact white mass (*compact nitrate of ammonia*). In doses not exceeding a scruple, this salt acts as a diuretic; and, according to the experiments of Wibmer[1] made on himself, it reduces the frequency of the pulse and the animal heat, without affecting the head, chest, or stomach. It had been given in fevers and acute catarrhs, in doses of from one to two scruples; but it is rarely employed.

It is the source from which *protoxide of nitrogen* is obtained. As it generates considerable cold while dissolving in water, it is sometimes used with other salts to form a freezing mixture. Lastly, it is occasionally employed to promote the combustion of organic substances during incineration.

35. AMMONIÆ ACETAS.—ACETATE OF AMMONIA.

Formula $NH^3,C^4H^3O^3,HO$; or NH^4,O,AcO^3. *Equivalent Weight* 77.

HISTORY.—A solution of this salt appears to have been first described in 1732 by Boerhaave, who introduced it into the Materia Medica. It was subsequently employed by Minderer or Mindererus; and hence obtained one of its names, *spiritus* seu *liquor Mindereri*. It is also termed *aqua ammoniæ acetatis*.

NATURAL HISTORY.—Acetate of ammonia, or acetate of the oxide of ammonium, is, I believe, always an artificial compound.

PREPARATION.—The *London College* directs *liquor ammoniæ acetatis* to be prepared with Sesquicarbonate of Ammonia, ʒix., or as much as may be sufficient; Diluted Acetic Acid, Oj. To the Acid add the Sesquicarbonate of Ammonia to saturation. The solution should be free from colour and smell: its specific gravity is 1·022.

The *Edinburgh College* orders "Distilled Vinegar (from French Vinegar in preference), f℥xxiv.; Carbonate [Sesqui] of Ammonia, ℥j.; mix them and dissolve the salt. If the solution has any bitterness, add by degrees a little distilled vinegar till that taste be removed. The density of the distilled vinegar should be 1·005, and that of Aqua Acetatis Ammoniæ 1·011."

The *Dublin College* directs "Of Sesquicarbonate of Ammonia in fine powder, ℥ijss., or a sufficient quantity; Dilute Acetic Acid, Oiij. To the acid introduced into a bottle, gradually add the sesquicarbonate of ammonia to saturation, and dissolve by shaking, but without the aid of heat. The specific gravity of this solution is 1·012."

Every equivalent of hydrated sesquicarbonate of ammonia requires two equivalents of anhydrous acetic acid to form a neutral compound, while three equivalents of carbonic acid gas are set free. $2NH^3,3CO^2,2HO + 2AcO^3 = 2(NH^3,AcO,HO) + 3CO^2$.

MATERIALS.		COMPOSITION.	PRODUCTS.	
1 eq. Hydrated Sesquicarbonate of Ammonia ..	118	3 eq. *Carbonic Acid* 66	3 eq. Carbonic Acid ..	66
		2 eq. *Water*........ 18		
		2 eq. *Ammonia* ... 34		
2 eq. Acetic Acid........	102		2 eq. Acetate Ammonia	154
	220			220

PROPERTIES.—When pure, this liquid is colourless. Any tint, therefore, which the solution of the shops may have, is referable to impurities either in the vinegar or in the sesquicarbonate.[2] Filtering it through powdered animal charcoal will usually remove any yellow or brown colour which it may have. If quite neutral, it will affect neither turmeric nor litmus paper. It is better, however, to have a slight excess of acid present than of sesquicarbonate, for if the latter predominate, the solution is much more irritant; and if employed as a collyrium, it might produce inconvenient results.

---

[1] *Die Wirkung der Arzneimittel und Gifte*, Bd. i. S. 130, Munchen, 1831.

[2] For some remarks on the different strengths of this preparation in the different European pharmacopœias, see Mohr, in the *Berlinisches Jahrbuch für die Pharmacie*, Bd. xliii. S. 253, Berl. 1840.

Characteristics.—It is totally dissipated by heat. With nitrate of silver it yields crystals (*acetate of silver*) soluble in water. When concentrated it evolves vapours of acetic acid on the addition of strong sulphuric acid, and gives out ammonia if potash or lime be mixed with it. With sesquichloride of iron it yields a red liquor (*peracetate of iron*).

COMPOSITION.—By evaporating a saturated solution of acetate of ammonia under the exhausted receiver of the air-pump, and over sulphuric acid, crystals of the acetate are obtained. They are transparent oblique rhomboidal prisms, and consist, according to Dr. Thomson, of

	Atoms.	*Eq. Wt.*	*Per Cent.*
Acetic Acid	1	51	38·931
Ammonia	1	17	12·977
Water	7	63	48·091
Crystallized Acetate Ammonia	1	131	99·999

The quantity of dry or anhydrous acetate of ammonia contained in this solution varies with the strength of the acetic acid or of the distilled vinegar. According to Mr. Phillips, 100 grs. of distilled vinegar contain 4·6 per cent. of acetic acid; and consequently 100 grains of liquor ammoniæ acetatis, prepared from such vinegar, would be composed as follows:—

Acetate of Ammonia (NH^3,AcO^3)	6·0407
Water	93·9593
Liquor Ammoniæ Acetatis	100·000

[Distilled vinegar is now ordered only in the Edinburgh Pharmacopœia. In the present process of the London College, diluted acetic acid is very properly substituted for distilled vinegar, but the strength of the solution is not altered. —ED.]

IMPURITIES.—This solution ought neither to be discoloured by the addition of hydrosulphuric acid, nor to throw down any precipitate by nitrate of silver or chloride of barium. [If a precipitate be thrown down by the nitrate of silver in a concentrated solution of the acetate, it should be re-dissolved by water or by the addition of nitric acid.] These substances, therefore, may be employed to detect, respectively, metallic matter, hydrochloric acid or a chloride, and sulphuric acid. Pure acetate of ammonia occasions no precipitate with diacetate or acetate of lead; but the liquor ammoniæ acetatis of the shops usually does, owing to the presence of carbonic acid. It should be quite neutral to test paper.

[In addition to the above tests, we find the following:—

> The solution is free from colour and smell. Its specific gravity is 1·022. It does not change the colour of litmus or turmeric. Ammonia is evolved on the addition of potash, and acetic acid on the addition of sulphuric acid. The residue left by evaporation is entirely destroyed by heat.—*Ph. L.*]

PHYSIOLOGICAL EFFECTS.—In small doses this solution is regarded as a refrigerant: in large doses, diaphoretic, diuretic, and perhaps resolvent.

These effects, however, are not very obvious. Wibmer[1] took it in moderate doses, yet did not observe any diaphoretic, diuretic, or purgative effects from it; but he experienced headache and disturbed digestion. Dr. Cullen[2] says, "I have known four ounces of it taken at once, and soon after four ounces more without any sensible effect." The local operation of this solution is that of a mild stimulant.

USES. *a. Internal.*—It is employed in febrile and inflammatory diseases, and forms a constituent of the ordinary saline draught. It is given in conjunction with nitrate of potash, or tartar emetic, and sometimes with camphor and opium. When administered as a diaphoretic, its operation should be promoted by the use of tepid diluents and external warmth. [Used thus, it is of the greatest value as a remedy in Morbus Brightii.—ED.] Its diuretic effect is assisted by keeping the skin cool, and conjoining the spirit of nitric ether.

β. External.—Diluted with water it is sometimes employed as a discutient wash to inflamed and bruised parts. Mixed with six or seven times its volume of rose-water, to which a drachm or two of tincture of opium may sometimes be added, it is employed as a collyrium in chronic ophthalmia. It has also been employed with benefit in porrigo and other cutaneous diseases, and for inflamed nipples.

ADMINISTRATION.—It is given *internally* in doses of half a fluidounce to two or three ounces every five or six hours.

36. Ammoniæ Citras.—Citrate of Ammonia.

Formula $3NH^3,C^{12}H^5O^{11},3HO$; or $3NH^4O,\overline{Ci}$. *Equivalent Weight* 243.

Neutral citrate of the oxide of ammonium.—A solution of this salt is obtained by saturating lemon or lime juice, or a solution of a citric acid, with sesquicarbonate of ammonia. 201 grains of the ordinary commercial crystals of citric acid saturate 177 grains of hydrated sesquicarbonate of ammonia. But this neutral citrate cannot be obtained in the solid state; for by evaporation a portion of ammonia escapes, and an acid salt is produced, composed of $2NH^3,C^{12}H^5O^{11},2HO$; $2NH^4O,\overline{Ci}$. Brande states that a crystallizable salt, $=NH^4O,2HO,\overline{Ci}$, may also be obtained. Liquid citrate of ammonia is employed either in the still or effervescent form as a cooling saline diaphoretic in febrile disorders.

[LIQUOR AMMONIÆ CITRATIS, L.; *Solution of Citrate of Ammonia.*—Citric Acid, ℥iij.; Distilled Water, Oj.; Sesquicarbonate of Ammonia, ℥iiss., or as much as may be sufficient. Dissolve the acid in the water, and add the sesquicarbonate to saturation.—Dose, ʒij. to ℥j.]

37. Ammoniæ Tartras.—Tartrate of Ammonia.

Formula $2NH^3,C^8H^4O^{10},2HO$; or $2NH^4O,\overline{T}$. *Equivalent Weight* 184.

Neutral tartrate of the oxide of ammonium.—A solution of this salt is prepared by saturating 150 grs. of crystallized tartaric acid with 118 grs. of the hydrated sesquicarbonate of ammonia. It may be obtained in the form of prismatic crystals, $2NH^3,\overline{T},4HO$; or $2NH^4O,\overline{T},2HO$. The effects and uses of tartrate of ammonia resemble those of the citrate. It is employed either in the effervescent or still form.

If the tartaric acid be in excess, a difficultly soluble crystalline precipitate of *bitartrate of ammonia*, $NH^3,\overline{T},2HO$, or $NH^4O,\overline{T},HO$, is obtained.

---

[1] *Die Wirkung*, &c.

[2] *Materia Medica.*

38. Ammoniæ Oxalas.—Oxalate of Ammonia.

Formula NH^3,C^2O^3,HO; or $NH^4O,\bar{O}$. *Equivalent Weight* 62.

Oxalate of the oxide of ammonium.—In the Edinburgh Pharmacopœia this salt is directed to be prepared as follows: Take Oxalic Acid, ℥iv.; Carbonate [Sesquicarbonate] of Ammonia, ℥viij.; Distilled Water, Oiv. Dissolve the carbonate in the water, add gradually the acid, boil, and concentrate sufficiently for crystals to form on cooling. The prismatic crystals thus formed consist of $NH^3,C^2O^3,2HO$; or NH^4O,C^2O^3,HO. By heat they suffer decomposition, and yield *oxamide* (*oxalamide*), composed of HN^2,C^2O^2. Oxalate of ammonia was introduced into the Edinburgh Pharmacopœia as a test for calcareous solutions, with which it produces a white precipitate (*oxalate of lime*), which is readily soluble in nitric acid, but is only moderately soluble in hydrochloric acid. It does not occasion any precipitate in the solutions of the magnesian salts; hence it is a valuable agent for separating lime from magnesia. According to the experiments of Drs. Christison and Coindet,[1] it is but little inferior in the energy of its operation on the body to oxalic acid. Ninety grains, which contain thirty-six grains of oxalic acid, killed a strong cat in nine minutes. The symptoms were tetanus and coma.

39. Aër.—Atmospheric Air.

Although atmospheric air is not, strictly speaking, an article of the Materia Medica, yet its relations to life, health, and disease, are so manifest and important, and its agencies in pharmacy and materia medica so numerous, essential, and influential, that a work like the present, in which constant reference is made to atmospheric air, can scarcely be considered complete without some notice of this agent.

1. *Definition.*—The atmosphere is that transparent and elastic fluid which surrounds and encloses the earth with which it revolves.

2. *Extent.*—There is reason to believe that it is of finite extent,[2] and that it reaches only to about forty-five miles from the surface of the earth.

3. *Physical properties.*—Like other aëriform bodies, air is elastic, and is, therefore, compressible and expansible. When pure, it is odourless and tasteless. At 60° F. and 30 in. bar., 100 cubic inches of pure dry atmospheric air weigh about 31 grs. troy.[3] Its density at the same temperature and pressure is assumed as the standard of comparison for the densities of other gaseous or aëriform bodies; and its sp. gr., therefore, is said to be 1·000.

As air has weight it must necessarily exert pressure, the amount of which is liable to variation. The mean pressure is assumed in England to be equal to a column of mercury of 30 English inches; in France to one of 76 centimetres, or 860 millimetres (=29·92 English inches); and in Germany to one of 28 Paris inches (=29·83 English inches). As mercury at 60° F. is about 13·568 times as heavy as water, it follows that a column of 30 inches of mercury is equal to one of water of $30 \times 13{\cdot}568 = 407$ inches (=33·92 feet); and as a cubic inch of water at 60° weighs about 252·5 grs., it follows that the mean pressure of the air on each square inch of surface is equal to $252{\cdot}5 \times 407 = 14{\cdot}68$ lbs. avoirdupois (usually assumed to be 15 lbs.) The density and temperature of the atmosphere diminish with its elevation; but no constant relation is found to exist between altitude and either density or temperature. In a general way, however, it may be stated that for every 1000 feet of elevation the mercury falls one inch; and for every 100 yards of ascent the temperature falls 1° F.

4. *Composition.*—Of the constituents of the atmosphere some are constant, others

---

[1] *Edinburgh Medical and Surgical Journal*, vol. xix. p. 190.

[2] Wollaston, *Phil. Trans.* for 1822.

[3] The most accurate recent experiments on the weight of atmospheric air are those of Prout (*Report of the First and Second Meetings of the British Association*, p. 566, 1833) and Regnault (*Ann. de Chim. et de Phys.* 3me sér. t. xiv. p. 211, 1845). The following are the results of their observations:—

Cub. In.	*Inches.*	*At 32° F.*	*At 32° F.*	*Authority.*
100 Air dry, and deprived of carbonic acid..	Bar. 30 ..	32·7958 grs. ..	31·0117 grs. ..	Prout.
100 " " " " "	Bar. 29·92 ..	32·7046 grs. ..	30·9407 grs. ..	Regnault.

accidental. The *constant* components are oxygen, nitrogen, aqueous vapour, and carbonic acid. These gaseous or aëriform bodies are in a state of mixture, not of chemical combination. The relative proportion of oxygen and nitrogen to each other is extremely uniform, and is scarcely, if at all, influenced by season, wind, weather, country, altitude of the air, or even the salubrity of it. From the recent experiments of Dumas and Boussingault, Brunner, and others, we may assume the composition of pure dry air to be as follows:[1]—

	By measure.	*By weight.*
Oxygen	20·8	23
Nitrogen	79·2	77
Air dry, and deprived of carbonic acid	100·0	100

The proportions of carbonic acid and aqueous vapour are inconstant. Perhaps as an average we may assume that land air contains $\frac{1}{2000}$th of its volume of carbonic acid gas.

---

[1] In 1841, Dumas and Boussingault (*Ann. Chim. Phys.* t. lxxviii.) analysed the air of the Jardin des Plantes, at Paris, and on the same day Brunner examined that of Bern, and Martins and Bravais that of the Faulhorn (about 8800 feet above the level of the sea). [We subjoin a summary of the results:—

Mean quantity of oxygen in 100 *parts*, by weight, *of dry air deprived of carbonic acid.*

	Oxygen per cent.
At Paris, from April 27th to Sept. 22d, average of ten experiments (Dumas and Boussingault)	23·07
At Bern, average of three experiments (Brunner)	22·95
On the summit of the *Faulhorn* (Alps, 8800 feet), average of four experiments (Martins and Bravais)	22·98

The following summaries are added from the notes of the author:—

At Guadaloupe (W. I.), November 1842, average of eight experiments	22·97
At Copenhagen, November 17 to December 22, 1841	23·01
At Elsinore, February 1852	23·03
[Between Havre and Copenhagen, August 1841 to May 1842 (average)	22·86]

The subjoined table, which we have compiled from Dalton's researches, contains some additional facts (23 parts by *weight* of oxygen are equal to 20·8 parts by *volume*):—

	Feet.	*Experiments.*	*By Volume.*	*Oxygen per cent.*
Helvellyn	3000	7	......	20·58
Snowdon	3570	10	......	20·65
Mont Blanc	6000	4	19·4	20·2
Simplon	6000	4	19·53	19·98
Wangen Alps	4000	4	20·11	20·45
Al. Ascent	9600	7	20·2	20·7
In Manchester	......	4	......	20·88
In open places	......	7	......	21·1
In the country	......	...	......	21·
In crowded rooms	......	...	20·23	20·42
Mean result	......	...	......	20·36

These results prove, that the proportion of oxygen is subject to but little variation over a very wide extent of the earth's surface. According to Dalton's table, the proportion of this constituent is smaller around the summits of lofty mountains than at lower levels.

Another fact worthy of notice is, that within the period during which an accurate method of analysis has existed, there has been no perceptible change in the proportion of oxygen in the atmosphere. Oxygen is constantly being removed from the atmosphere by animals, as well as by numerous natural and artificial processes: hence it follows, either that there is a perfect compensation, or that the quantity lost during a period of fifty years is too small to be appreciated by the most delicate processes of analysis at present known to chemists.

One of the earliest and most trustworthy analyses of the air was made by Gay Lussac in the yaer 1805. The mean proportion of oxygen by volume found by him in the air of Paris was 21·006 per cent. The mean of three experiments performed by Despretz in 1822,—*i. e.* seventeen years later,—gave precisely the same result, and an analysis, made by Regnault in 1851, gave the proportion as 20·93. An analysis of the air of London, made by one of us in October 1841, gave the proportion of oxygen as 20·8. These facts prove that there is no perceptible change in the proportion of this constituent of the atmosphere during a period of nearly half a century.—Ed.]

The average proportion of aqueous vapour is more difficult to estimate, as the quantity is constantly fluctuating. [It varies with the temperature of the air and the conditions which aid or retard evaporation.] It is more abundant with south and westerly winds than with cold weather. The following table was drawn up by the late Dr. Henry;[1] it represents the supposed composition of the air and the pressure exerted by each ingredient in supporting the mercury of the barometer; and although possibly not quite accurate, is a close approximation to the truth:—

	By measure.	*By weight.*	*Pressure in inches of mercury.*
Nitrogen	77·5	75·55	23·36
Oxygen	21·0	23·32	6·18
Aqueous vapour	1·42	1·03	0·44
Carbonic acid	0·08	0·10	0·02
	100·00	100·00	30·00

The *accidental* constituents of the atmosphere may be regarded as adventitious or extraneous. Some of them are inorganic, others organic. The inorganic constituents are derived from various sources. Some of them are products of electrical operations going on in the atmosphere; some are gases or vapours derived from particular localities of the earth or from operations on the surface of the earth; others are finely-divided solid bodies raised by the wind from the earth's surface, or volcanic dust projected into the atmosphere and suspended in the air. Many of them are detectable in the rain water which falls after long-continued drought, and have therefore been before alluded to (see *ante*, p. 297). Ammonia, probably in the form of carbonate, may be detected in rain and snow water. It is derived from the decomposition of animal and vegetable nitrogenous principles. It is an important constituent of the atmosphere, on account of its being a probable source of the nitrogenous principles of plants. It exists in such minute proportion as to be inappreciable in the small amount of air usually submitted to analysis; but it may be detected by adding hydrochloric acid to the first portions of rain which falls after long-continued dry weather and evaporating, by which sal ammoniac is obtained.[2] Traces of sulphuretted hydrogen are indicated by the tarnish of silver. Sulphurous and sulphuric acids are found in the air of London and other places where coal is consumed as fuel. Traces of sulphate of ammonia are also found. The small stellated spots sometimes seen on dirty windows consist of this salt (Brande). Hydrochloric acid or common salt is found in the vicinity of the sea. Nitric acid and various alkaline, earthy, and metallic salts, have been detected in rain water (see *ante*, p. 297), and have been derived from the atmosphere. To these must be added finely-divided carbonaceous matter, which constitutes the dark colour of smoke from coal fires, and which is deposited under the popular name of "blacks."

Dr. Prout[3] has hinted at the possible diffusion of a compound of selenium, or of some active ingredient like this, in the atmosphere as a cause of epidemic catarrh. In proof of the diffusion of some heavy matter through the air on the occasion of some epidemics, he states that on the 9th of February, 1832, the wind, which had previously been west, veered round to the east; the weight of air suddenly appeared to rise above the usual standard, and at this time the first cases of epidemic cholera were reported in London; and he inferred that the cholera was owing to the matter which thus produced the additional weight of the air.[4] [Further observations, however, have not shown any connection between the density of the atmosphere and the outbreak of cholera in different localities. On the properties of ozone as a constituent of the atmosphere we have elsewhere made some remarks (see *ante*, p. 277).—ED.]

Organic matters of various kinds—some organised, others not—exist in the atmosphere. Nitrate of silver is employed as a test of their presence in rain and snow water (see *ante*, p. 297); but there is no reason for assuming with Zimmermann (see *ante*, p. 297) that the organic matter of rain water, called by him *pyrrhin,* is of a peculiar kind. The various odorous emanations of animals and plants are of an organic nature. I have already had occasion to allude to miasma or malaria, the chemical nature of which is at present unknown, as well as to other dangerous emanations. Boussingault[1] detected an organic carbonaceous matter in the air of a marshy meadow, and found 0·0001 of hydrogen (he thinks as light carburetted hydrogen, or marsh gas, CH^2) in the air of Paris. Mr. Graham[2] contends that contagious matters are not volatile or truly vaporous, but "are highly organised particles of fixed matter, which may find its way into the atmosphere notwithstanding, like the pollen of flowers, and remain for a time suspended in it."

---

[1] *Elements of Experimental Chemistry*, vol. i. p. 298, 1826.

[2] [The best test for this purpose is a mixture of a saturated solution of arsenious acid and nitrate of silver. If ammonia or its carbonate be present in rain water, the addition of this test causes the production of the primrose yellow arsenite of silver. The absence of fixed alkalies should be first determined by evaporating a portion of the water.—ED.]

[3] *Bridgewater Treatise (Chemistry and Meteorology)*, p. 350.

[4] *Ibid.*; also *Report of the First and Second Meetings of the British Association*, p. 566, 1833.

Minute microscopic organisms, both vegetable and animal, doubtless exist in the atmosphere; but their presence has, in many instances, been assumed without evidence, either for the purpose of accounting for the development of infusorial animals and cryptogamic plants, and of thereby obviating the necessity of admitting their spontaneous generation,—or for the purpose of accounting for the propagation of infectious diseases. But the whole of this subject is enveloped in deep obscurity.

5. *Effects and uses.*—I must refer my readers to works on physiology for an account of the agency of the atmosphere in the animal and vegetable kingdoms. It will be sufficient, therefore, to observe that, with reference to the atmosphere, animals and plants are engaged in antagonistic operations:

Vegetables	*Animals*
Decompose carbonic acid.	*Produce* carbonic acid.
" water.	" water.
" ammonia.	" ammonia.
Evolve oxygen.	*Absorb* oxygen.

It is obvious, from this table, that vegetables purify the atmosphere, while animals deteriorate it.

I have already (see *ante*, pp. 72) noticed some of the circumstances which render the atmosphere of certain localities insalubrious.

The dangerous and, in many cases, fatal effects of the entrance of air into the veins[3] do not require consideration in a work on Materia Medica.

The important agency of the atmosphere in pharmaceutical operations is well known. By its aid artificial heat and light are obtained. It is an exhaustless source of oxygen in numerous operations (as of calcination, roasting, acetification, &c.) It is the ultimate source from whence nitric acid is produced, for nitrification is effected by the oxidation of ammonia. To it we are indebted for the purest form of natural water (see *ante*, p. 297).

Most of the deteriorations which time effects in medicinal agents are due to the destructive agency of the atmosphere; mainly to the influence of oxygen [ozone?] and aqueous vapour, and in part also, to the presence of other bodies.

6. *Purification and disinfection of the atmosphere.*—The purification of the atmosphere is naturally effected in two ways—by the chemical changes which the air effects on the various substances thrown into it, and by the agency of the vegetable kingdom already alluded to. "The atmosphere," says Mr. Graham, "contains within itself the means of its own purification, and slowly, but certainly, converts all organic substances exposed to it into simpler forms of matter, such as water, carbonic acid, nitric acid, and ammonia."

For the purpose of destroying putrescent effluvia, organic fetors, and miasmata, the agents called disinfectants or deodorisers are employed. I have already had occasion to refer to the disinfecting powers of heat and of the class of chemical agents to which the denomination of *disinfectants* is usually applied (see *ante*, p. 166). Of the gaseous disinfectants, Professor Graham thinks "that sulphurous acid gas (obtained by burning sulphur) is preferable, on speculative grounds, to chlorine. No agent checks more effectually the first development of animal or vegetable life. This it does by preventing oxidation. In the same manner it renders impossible the first step in putrefactive decomposition and fermentation. All animal odours and emanations are most immediately and effectively destroyed by it. The fetid odour from the boiling solution of cochineal (for instance), which is so persistent in dye houses, is most completely removed by the admission of sulphurous acid vapour (T. Graham)."

---

[1] *Ann. Chim. et Phys.* lvii. 1834.

[2] *Elements of Chemistry*, 2d edit. p. 336.

[3] On this subject consult Dr. M'Cormack's *Inaugural Dissertation on the Presence of Air in the Organs of Circulation*, Edinb. 1837. Also a review of this work, as well as of the papers of Bouillaud, Amussat, and Velpeau, on the same subject, in Dr. Forbes's *British and Foreign Medical Review*, vol. vi. p. 456; likewise Chelius's *System of Surgery*, by South, vol. ii. p. 856.—The subject has recently acquired additional interest from the death of a patient, caused by air entering a vein, divided whilst inserting a seton in the neck (*Lond. Med. Gaz.* April 7, 1848, p. 608).

ORDER XI. COMPOUNDS OF POTASSIUM.

40. Potassium.—Potassium.

Symbol K. *Equivalent Weight* 39.

Kalium ; Basis of Potash.—Discovered by Davy on the 6th October, 1807. Procured for commercial purposes in decomposing potash by carbon. It is a bluish white metal of great lustre. Its specific gravity is 0·86507. Its consistency is that of wax. Its vapour is green [but it burns in air with a violet flame]. It rapidly attracts oxygen from the air and from moisture, and takes fire when thrown on water or ice. It is usually preserved in Persian naphtha. Flat discs of it may be conveniently prepared by pressing a globule of the metal between two plates of glass or between the fingers covered with naphtha. Potassium has been now and then employed as a cautery or moxa. Graefe[1] used it in four cases of gonalgia (pain in the knee), in two of which it proved successful; and Chevallier[2] (at the suggestion of Dumeril) proposed, its use as a substitute for the actual cautery. Graefe placed it close to the skin, and set fire to it by a few drops of water. The surrounding parts were protected by a piece of pasteboard having a circular aperture, through which the potassium was applied. To circumscribe the effect a little more carefully, as well as to protect the operator from the sputtering of the burning metal, he subsequently employed a hollow brass cylinder, of about an inch in length and an inch in diameter, with a handle a foot long. The cylinder was introduced into the aperture of the pasteboard, and the potassium placed within it. When the combustion was over, the cylinder was removed, and the cauterised spot cleaned with lint. The skin confined within the cylinder was converted into a brownish-yellow eschar. Graefe thinks this mode of cauterisation useful in poisoned wounds, as the bites of rabid animals.

41. Potassa.—Potash.

Formula KO. *Equivalent Weight* 47.

Synonymes.—*Protoxide of Potassium ; Kali ; Vegetable Alkali.*

History.—Caustic alkaline solutions were probably known to the Greeks and Romans. We learn from Pliny[3] that soap was made in his time from tallow and wood-ashes; and we may therefore conclude that some method was known of depriving the alkaline carbonate of its carbonic acid. Paulus Ægineta[4] describes the method of making a caustic lixivium, as does, also, Geber.[5] Black, however, in the year 1756, first distinguished chemically the caustic alkalies from their carbonates.

Natural History.—Potash in combination with acids is found in both kingdoms of nature.

a. In the Inorganised Kingdom.—Potash is found, in the mineral kingdom, in combination with sulphuric, nitric, silicic, and perhaps carbonic acids. As an ingredient of rocks, it is more abundant than soda. [It forms from eleven to fourteen per cent. of the felspar of granite.—ED.]

---

[1] Dierbach's *Die neuesten Entdeckungen in der Materia Medica*, 1er Bd. p. 484, 1837.

[2] *Journ. de Chimie Médicale*, Feb. 1845, p. 90.

[3] *Hist. Nat.* lib. xxviii. cap. 51.

[4] Adams's translation of Paulus Ægineta, vol. ii. p. 264, and vol. iii. p. 185.

[5] *Invention of Verity*, ch. iv.

β. IN THE ORGANISED KINGDOM.—In organised beings, potash is met with in combination with phosphoric, sulphuric, nitric, carbonic, and various organic acids. It occurs more abundantly in vegetables than in animals.

PREPARATION.—Anhydrous potash is obtained by heating potassium in a current of dry oxygen,—by the partial deoxidation of peroxide of potassium,—or by heating one atom of hydrate of potash with one of potassium. $K + KO,HO = 2KO + H$.

PROPERTIES.—It is a hard, white, brittle substance, fusible at a bright red heat [and volatile at a higher temperature], sp. gr. about 2·656, odourless, extremely caustic, and powerfully alkaline.

Characteristics.—A solution of potash or of a neutral potash salt is recognised by the following characters:—Solutions of the hydrosulphurets, ferrocyanides, and carbonates, produce no precipitate with it. Solutions of tartaric (in excess), perchloric, and carbazotic acids, occasion crystalline precipitates of the bitartrate, perchlorate, and carbazotate of potash respectively. [A solution of fluosilicic acid also throws down an insoluble fluosilicate of potash.—ED.] A solution of bichloride of platinum produces a yellow precipitate ($KCl,PtCl^2$).[1] Lastly, potash and its salts communicate a violet tinge to the flame of alcohol.

Free potash is distinguished from its salts by its communicating a green colour to the infusion of red cabbage or syrup of violets; by its reddening turmeric, and restoring the blue colour of litmus reddened by an acid; by its not effervescing on the addition of an acid; [by its yielding a brownish black precipitate with nitrate of silver;] by its soapy feel; by its solubility in alcohol; and by its dissolving [recently precipitated hydrate of] alumina. Anhydrous potash is more difficultly fusible and harder, and is a worse conductor of electricity, than the hydrate of potash.

COMPOSITION.—Pure anhydrous potash has the following composition:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Berzelius.*	*Davy.*	*Gay Lussac and Thenard.*
Potassium	1	39	82·98	83·0484	85	83·371
Oxygen	1	8	17·02	16·9516	15	16·629
Potash	1	47	100·00	100·0000	100	100·000

PHYSIOLOGICAL EFFECTS.—In considering the effects of potash, we have to notice its effects as a constituent of other substances, and also its effects when taken in the free state.

1. *Effects of potash as a constituent of other substances.*—Potash and its basis potassium are essential constituents of the human body. They preponderate in the juice of flesh and in the milk. It is obvious, therefore, that they are necessary ingredients of our food; and that, if they be deficient or absent, nutrition will be imperfect. It follows, also, that for the cure of disorders resulting from the use of food deficient in potash, the administration of this alkali is requisite.

Dr. Garrod[2] is of opinion that scurvy is produced by a deficiency of potash in the food; and that, by the addition of potash (in the form of some salt) to their food, scorbutic patients will recover without the use of either succulent vegetables or milk. He gives the following table of the amount of potash in several articles of food:—

---

[1] [The formula adopted by the author is that commonly assigned, yet $KO + PtCl^2$ cannot without the evolution of oxygen produce $KCl + PtCl^2$. On the addition of pure potash to pure bichloride of platinum, the yellow salt is formed, but there is no apparent evolution of oxygen.—ED.]

[2] *Monthly Journal of Medical Science*, Jan. 1848.

Table *shewing the quantity of potash* (KO) *contained in one ounce avoirdupois* (=7000 grs.) *of the following alimentary substances.*

	Grains of potash.		*Grains of potash.*
Baker's best bread (City)	0·259	Salt beef boiled (slightly salted)	0·572
Best bread (West-end)	0·257	Boiled mutton	0·637
Home-made bread, probably containing potato flour	0·262	Dutch cheese	0·230
Best white flour	0·100	Boiled potatoe (large size)	1·875
Bran	0·609	Raw potatoe (small)	1·310
Rice	0·005	Boiled potatoe, without peel and well done, water containing much potash	0·529
Rice	0·011	Onion (small)	0·333
Oatmeal	0·054	London milk (1 fluid ounce)	0·309
Split peas	0·529	Orange (not ripe), including septa	0·675
Raw beef	9·599	Lime-juice (1 fluid ounce)	0·852
Salt beef raw	0·394	Lemon-juice (1 fluid ounce)	0·846

The best antiscorbutics, therefore, according to Dr. Garrod, are those which contain the largest amount of potash. These are potatoes (especially when unpeeled and not too much boiled), fruits (as oranges, lemons, limes, grapes, and gooseberries), milk, fresh meat, fresh vegetables (as cabbages, turnips, onions, garlic, and leaks), pickles, spruce beer, wort, malt liquors, and wines (especially the lighter kinds). From Dr. Garrod's table it would appear that rice oatmeal, and even wheat-flour, belong to what might be called scorbutic foods. Moreover it would appear that wheat-bread is superior to wheat-flour in the amount of potash which it contains,—a circumstance which probably depends on the use of potatoes and alum in its manufacture. According to Dr. Garrod, when the weekly amount of potash in the food was 186 grs., the inmates of the Crediton Union Workhouse remained healthy; but when, by the substitution of rice potatoes, the weekly consumption of potash was reduced to 51 grains, scurvy broke out Dr. Garrod treated scurvy by giving daily from twelve to twenty grains of a salt of potash (bitartrate, acetate, carbonate, or phosphate) mixed with syrup and water.

Dr. Garrod's views are interesting on account of their novelty, ingenuity, and importance. But it must be borne in mind that his statements or conclusions, on which this theory of scurvy mainly rests, require confirmation; and that, should many of them be eventually established, it by no means follows that a deficiency of potash is the sole cause of scurvy. Indeed, there is reason to believe that scurvy sometimes exists when there has been no want of this alkali in the food. It prevailed, for example, to a frightful extent, in 1822, in his Majesty's ship Leander, despite the plentiful administration of large quantities of lemon juice,[1] which, according to Dr. Garrod, is rich in potash and is highly antiscorbutic. Salted meats in the preparation of which nitre has been used ought to be antiscorbutic.[2]

In milk, the salts of potash greatly preponderate over those of soda; and hence a plentiful supply of potash is [supposed to be] one of the conditions necessary for the secretion of this fluid. In this sense potash may be said to belong to the *galactophora*, or milk-promoters. It is remarkable, however, that sulphate of potash has been reputed as a *galacifuge*, or milk-represser. The beneficial effects of the *grape-cure* (*cure de raisins*) in the treatment of inflammatory dyspepsia and other maladies, are probably in part due to the influence of the potash taken into the system. Of the ill effects produced by the long-continued use of large quantities of substances abounding in potash we have no positive evidence.

---

[1] See my *Treatise on Food and Diet*, p. 358.

[2] [Experience is here opposed to theory—see post, *Nitrate of Potash*.—Ed.]

2. *Effects of free potash.*—By free potash is meant potash uncombined with acids. It includes, therefore, anhydrous potash, hydrate of potash, and solutions of caustic potash. Potash in the anhydrous state is not, however, employed in medicine; and our remarks, therefore, must apply to the two latter preparations.

α. On Vegetables.—Caustic potash promptly destroys those parts of living plants with which it is placed in contact, and even in the dilute state kills haricots (*Phaseolus vulgaris*) in a few hours.[1]

β. On Animals generally.—It acts on animals generally as an energetic caustic poison. Orfila[2] found that, when injected into the jugular vein of a dog, it coagulated the blood, and caused speedy death. It is, however, remarkable that, when mixed with the blood out of the body, it not only does not coagulate it, but, by dissolving the fibrin, actually prevents its spontaneous coagulation.

γ. On Man.—In its local and remote action, potash partakes of the properties of the alkalies generally, and which have been already noticed. Its local action is exceedingly energetic. It neutralises any free acid in the part to which it is applied; decomposes whatever ammoniacal salts may be present, causing the evolution of ammoniacal gas; and dissolves fibrin, albumen, gelatine, and mucus. Hence, rubbed between the fingers, it corrodes and dissolves the epidermis, and thereby gives rise to a soapy feel. These phenomena are to a certain extent comparable to those of saponification. As, then, potash, like the other alkalies, forms soluble compounds with substances which enter largely into the composition of the organised tissues, we can readily explain Orfila's observation, that alkalies are, of all corrosive poisons, those which most frequently perforate the stomach;[3] for the intestinal mucus readily dissolves in alkalies, whereas it is coagulated by acids; so that the former are much more quickly brought in contact with the living tissues. These resist, for a certain time, the chemical influence of the caustics; but the affinities being powerful, the vital properties soon cease to offer opposition—the part dies (*biolysis*) and the tissues are speedily dissolved (*morpholysis*). Hence, if a large quantity of potash be swallowed, the most violent symptoms are observed, though they are of the same general kind as when the mineral acids have been taken (see p. 370). The matters vomited have, however, a well-marked alkaline reaction. Like other corrosives, potash powerfully depresses the heart's action.

When liquor potassæ is taken in small doses, and properly diluted, it destroys the acidity of the contents of the stomach, which the recent investigations of physiologists have shown to be essential to the digestion of albuminous substances. Hence the continual use of it is liable to prove injurious, by altering the chemical properties of the healthy ventricular secretion. Like other alkalies, it may perhaps aid the digestion and absorption of fatty substances. In somewhat larger doses, it acts as a slight irritant, augments the secretions of the alimentary canal, becomes absorbed, and communicates an alkaline quality to the urine. Moreover, the modification thus produced in the quality of the renal secretion is accompanied by an increase in the quantity. By continued use, potash acts as a liquefacient, resolvent, and impoverisher of the blood.

---

[1] Marcet, in De Candolle, *Phys. Végét.*

[2] *Toxicol. Génér.*

[3] [Poisoning by potash is comparatively speaking rare, but in the few cases which have occurred the stomach has *not* been found perforated.—ED.]

USES.—Caustic potash is employed for various purposes in medicine, the principal of which are the following:—

α. As an escharotic.—Potassa fusa is sometimes used as a caustic, though its employment is not free from objection; for its great deliquescence occasions some difficulty in localising its action. It may be employed for the production of an issue, and is used thus:—Apply to the part one or two layers of adhesive plaster, in the middle of which is an aperture of the exact size of the intended issue. Then moisten the *potassa fusa*, or the *potassa cum calce*, and rub it on the part until discolouration is observed. Wash, and apply a linseed-meal poultice; and when the eschar is detached, insert the pea. Issues, however, are speedily and more conveniently made by the lancet than by caustic. In bites by poisonous animals—as venomous serpents, mad dogs, &c., this escharotic may be used with advantage. Mr. Whateley[1] recommends the *potassa fusa* as the agent for arming caustic bougies to be applied in strictures of the urethra; but the practice appears so dangerous (particularly on account of the deliquescence and violent action of the caustic), that I believe it is now rarely, if ever, resorted to. There are many other cases in which this substance is employed as a caustic: for example, to destroy warts and fungoid growths of various kinds, and to open abscesses; but for the latter purpose the lancet is to be preferred.

β. As an *antacid*, we resort to the *liquor potassæ* in various affections of the digestive organs which are attended with an inordinate acidity of stomach, known by acid eructations, cardialgia, and other dyspeptic symptoms. It must, however, be evident, that the neutralisation of the acid is merely palliative. But the continued employment of alkalies frequently diminishes, temporarily, the tendency to acid secretion. Commonly, it is found that the cases calling for their employment are those benefited by tonics, and hence they are usually given in some tonic infusion; as the infusion of calumba, or of gentian, or of quassia. Their beneficial effects are frequently manifested in those forms of dyspepsia which result from the use of spirituous liquors.

γ. To render the urine alkaline, or to diminish its acidity.—In preternatural acidity of urine, especially in lithic acid deposits, potash is used as an alterative lithic. But in general, I believe the carbonate or vegetable salts of the alkalies are preferable, in these cases, to the caustic alkalies; as they are equally effective in rendering the urine alkaline, and are less injurious to the digestive organs.[2] The alkalies act as solvents for lithic acid, as the alkaline lithates are more soluble than the free acid. They also probably prevent the formation of this acid, or neutralise the free acid in the urine, which is the immediate cause of the precipitation of the lithic acid. As a lithonlytic, caustic potash has been exhibited both by the mouth and by injection into the bladder. In all these cases care should be taken to avoid employing it when there is any tendency to the deposition of the phosphates. In the treatment of the lithic acid diathesis, it is to be remembered that the use of alkalies is, to a certain extent, a palliative mode of treatment, and that, to be successful, it should be conjoined with other means of cure.

---

[1] *An Improved Method of Treating Strictures of the Urethra*, Lond. 1804.

[[2] The vegetable salts of the alkalies are far more effective in producing an alkaline state of urine than is either caustic potash or its carbonate. The latter may, indeed, sometimes be exhibited in scruple doses three times a day for a week or more without bringing about the change; and liquor potassæ is well known only to affect the urine after long use.—ED.]

δ. *As an antiplastic, liquefacient, and resolvent.*—For these purposes the alkaline carbonates are to be preferred to the caustic alkalies.

ε. As a *resolvent* and *sorbefacient*, induration and enlargement of the lymphatic and secreting glands, for example, in bronchocele, mammary tumours, affections of the testicle, diseases of the mesenteric glands, induration of the liver and salivary glands, &c., liquor potassæ has been used with benefit. I have seen it remarkably beneficial in excessive enlargement of the lenticular or glandular papillæ at the base of the tongue.

ζ. In *syphilis* and *scrofula*, liquor potassæ has been employed with advantage. Some of the most obstinate and troublesome forms of the venereal disease frequently occur in scrofulous subjects, in whom mercury is not only useless, but absolutely prejudicial. In cases of this kind the liquor potassæ, taken in the compound decoction of sarsaparilla, is often very serviceable. In scrofula, the long-continued use of the caustic alkalies (as potash and ammonia) has been attended with remarkably beneficial effects. Caustic potash was most extensively employed by Mr. Brandish,[1] during many years, in the treatment of scrofula and other chronic diseases, and, according to his report, with singular success. It is, however, more successful in young than in old persons, and in those of fair and light complexion than in the dark and the swarthy.

η. Liquor potassæ is employed as a *diuretic in dropsy*, especially when this disease arises from glandular enlargements, or other causes likely to be relieved by alkaline remedies. It has also been found serviceable in dyspepsia with acid secretion, and in irritability of the gastric mucous membrane.

ϑ. In *irritable conditions of the urinary organs*, a combination of liquor potassæ and opium will be frequently found most beneficial, notwithstanding that alkalies are classed among the incompatibles of the latter substance. This combination I have also frequently found useful in allaying *uterine irritation*.

ι. In *chronic skin diseases*, especially psoriasis, pityriasis, lepra, acne, and lichen, the long-continued employment of liquor potassæ is sometimes attended with relief. In acne punctata, a weak alkaline solution (as ʒss. of liquor potassæ in a pint of soft water) is often employed, with the aid of a coarse towel and friction, to remove the thick sebaceous secretion from the follicles.

κ. In *rheumatism* and *gout*, especially when attended with lithic acid deposits in the urine, liquor potassæ may be advantageously administered.

λ. In *chronic bronchitis* with a very rough and viscid secretion, liquor potassæ is used to diminish the viscidity of the mucus.

μ. In *amenorrhœa*, potash has been employed as an emmenagogue.

ν. Sometimes a very dilute solution of potash has been used as a *stimulating wash* to ulcers.

ANTIDOTES.—See *ante*, p. 165.

---

[1] *Observations on the Use of Caustic Alkali in Scrofula and other Chronic Diseases*, Lond. 1811.

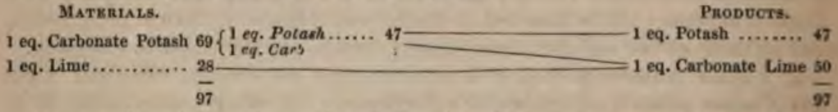
1. LIQUOR POTASSÆ, L.; *Potassæ Aqua*, E.; *Potassæ Causticæ Liquor*, D.; *Solution of Potash; Water of Caustic Potash; Aqua Kali puri: Lixivium Causticum*, or *Caustic Lye; Lixivium Saponarium*, or *Soap-Boilers' Lye*.—This is a solution of caustic potash. The history of the preparation of caustic alkaline solutions has already been given.

The *London College* orders of Carbonate of Potash, ℥xv.; Lime, ℥viij.; Distilled Water, boiling, *Cong.* j. Dissolve the Carbonate of Potash in half a gallon of the water. Sprinkle a little of the water upon the lime in an earthen vessel, and the lime being slaked, add the rest of the water. The liquors being immediately mixed together in a closed vessel, shake them frequently until they are cold. Then set aside [the mixture], that the carbonate of lime may subside. Lastly, keep the supernatant liquor, when poured off, in a well-stoppered green glass bottle.

The *Edinburgh College* directs of Carbonate of Potash (dry), ℥iv.; Lime recently burnt, ℥ij.; Water, f℥xlv. Let the lime be slaked, and converted into milk of lime, with seven fluidounces of the water. Dissolve the carbonate in the remaining thirty-eight fluidounces of water; boil the solution, and add to it the milk of lime in successive portions, about an eighth at a time,—boiling briskly for a few minutes after each addition. Pour the whole into a deep narrow glass vessel for twenty-four hours; and then withdraw with a syphon the clear liquid, which should amount to at least thirty-five fluidounces, and ought to have a density of 1·072.

The *Dublin College* employs of pure Carbonate of Potash, lb. j.; of fresh-burnt Lime, ℥x.; Water, *Cong.* j. and ℥vij. [The process is similar to that of the London College: the only difference is that the solution of carbonate is brought to the boiling point before the slaked lime is added.] The sp. gr. of this product is 1·068.

In all these processes the lime abstracts carbonic acid from the carbonate of potash, forming carbonate of lime, and the potash thus set free dissolves in the water: $KO,CO^2 + CaO = KO + CaO,CO^2$.



As more lime is usually employed than is sufficient to saturate the carbonic acid of the carbonate of potash, a portion of lime remains in solution. This may be got rid of by the addition of a solution of carbonate of potash as long as a precipitate forms. [By occasional exposure to air, as in opening the bottle, it is slowly precipitated as carbonate of lime.—Ed.]

The liquid should be decanted or drawn off by a syphon. Filters are objectionable, as the potash decomposes and partially dissolves them. Cotton and linen are less acted on by it than paper or woollen cloth, which are readily decomposed by it. The air must be excluded as much as possible during the process of filtration, as the liquor abstracts carbonic acid from the air. [Filtration is not necessary. After entire subsidence of the carbonate of lime, the liquid may be poured off clear for use, as directed by the Colleges.—Ed.]

The ebullition directed to be employed by the Edinburgh and Dublin Colleges has three advantages: it accelerates the chemical changes; it augments the density, and thereby promotes the subsidence, of the carbonate of lime; and lastly, it yields a purer product, as it effects the separation of the silica usually contained in the carbonate of potash, by giving rise to an insoluble combination of silica with lime and potash. But on the large scale, the inconvenience, expense, and danger attending the ebullition of considerable quantities of liquor potassæ, more than counterbalance the advantages above mentioned.

Liquor potassæ is a limpid, colourless, transparent, inodorous liquid, having an acrid taste. Prepared according to the London Pharmacopœia, its sp. gr. is 1·063; according to the Edinburgh Pharmacopœia, 1·072; while according to the Dublin College it is 1·068. It has a soapy feel when rubbed between the fingers, and reddens turmeric paper. It strongly attracts carbonic acid from the atmosphere, and, therefore, should be kept in closed vessels. It corrodes flint glass, and rapidly dissolves the oxide of lead; hence it should always be preserved in green glass bottles.

If the carbonate of potash ($2KO,2CO^2,3HO$) used in the preparation of liquor potassæ (Ph. Lond.) were absolutely pure, this solution would contain 5·537 per cent. of anhydrous potash. But the commercial carbonate is never quite free from impurity, and, therefore, the actual strength of the liquor is somewhat below this. If we assume that the relative proportions of potash and water were 1 atom potash and 90 atoms water, the composition would be as follows:—

	Atoms.	*Eq. Wt.*	*Per-Centage.*
Potash	1	47	5·484
Water	90	810	94·516
Liquor Potassæ	1	857	100·000

[Mr. Phillips states that 100 grains of the solution contain 6·7 grains of potash.]

PURITY.—It usually contains a small quantity of carbonate of potash, which may be detected by adding a portion of the alkaline liquid to an excess of strong nitric acid. The presence of carbonic acid is indicated by effervescence. Liquor potassæ is, however, rarely so pure as to stand the test of lime-water.[1] The presence of a very small quantity of alkaline carbonate is unobjectionable: nay, it is advantageous, by preventing any lime being held in solution. When pure liquor potassæ has been saturated with diluted nitric acid, it gives no precipitate on the addition of carbonate of soda, chloride of barium, or nitrate of silver: if the first cause a precipitate, it would indicate some earthy or metallic impregnation; if there be a precipitate insoluble in nitric acid with the second, we infer the presence of a sulphate; and lastly, if the third occasion a precipitate insoluble in nitric acid, a chloride is present. [There is generally a trace of chloride arising from the presence of chloride of potassium in the carbonate. For obtaining a pure solution, the carbonate resulting from the incineration of bitartrate of potash, or the crystallised bicarbonate dissolved and brought to the boiling point, should be employed.]

[One of the most frequent impurities which we have found in solution of potash is *oxide of lead*. This is owing to the solution having been kept in a flint-glass bottle, or to its having been prepared in a badly glazed vessel.

---

[1] [The purest solution of potash is rendered turbid by the addition of lime-water. The subsequent addition of distilled water causes the turbidness to disappear. A piece of clean potassium burnt on lime-water renders the liquid turbid, and a solution of potash, which produces no effervescence when added to strong nitric acid, is equally affected by lime-water. It is quite clear, therefore, that this effect does not indicate the presence of carbonic acid in the alkaline solution, and it follows that lime-water cannot be safely used as a test for carbonic acid in solution of potash. In employing nitric acid as a test, it is proper to observe that the alkaline solution should be added to the acid, and not the acid to the alkali. If the solution of potash be entirely free from carbonate, nitrate of silver throws down only a brown precipitate (oxide of silver). When, however, there is a trace of carbonate, a whitish precipitate soluble in nitric acid is subsequently formed.—ED.]

Pure solution of potash should acquire no change of colour by passing into it a current of washed sulphuretted hydrogen or by adding to it a drop of a solution of hydrosulphuret of ammonia. A brown or black discolouration indicates at once the presence of oxide of lead. The use of such a preparation is not only injurious in a medicinal view, but it is calculated to give rise to continual mistakes in the application of potash-solution as a test. Dr. Rees has pointed out that owing to the use of potash thus contaminated, albumen has been mistaken for sugar in testing urine,—the sulphur in the albumen giving to the urine a brown colour like that (of glucic acid) arising from the action of pure potash on grape sugar, by reason of its producing sulphuret of lead from the oxide of lead contained as impurity in the potash. We have known lead pronounced to be present in substances when impure potash had been thus used as a test; and subsequent trials have shown that there was no trace of lead except that which was contained in the potash.—ED.]

The specific gravity of this solution is 1·063. In 100 grains there are 6·7 grains of potash. Scarcely anything is thrown down from this solution by lime water; nor (when first treated with nitric acid) by carbonate of soda, chloride of barium, or nitrate of silver. The precipitate thrown down by bichloride of platinum is of a yellowish colour.—*Ph. L.*

The effects and uses of this liquid have been above described. The dose of it is *ten drops,* gradually increased to the extent of a *fluidrachm,* or even more,—carefully watching its effects. It may be conveniently exhibited in the infusion of orange-peel. With infusion of lemon-peel caustic potash forms a gelatinising mixture (see *Citrus Limonum*). Table beer completely disguises the nauseous flavour of the alkali, but the vegetable acid of the beer partly neutralises the alkali. Veal broth is another liquid for its administration. *Dr. Chittick's nostrum* for the stone is said to be a solution of alkali in veal broth.

BRANDISH'S ALKALINE SOLUTION.—Take of best American Pearlashes, lb. vj.; Quicklime, fresh prepared; Woodashes (from the Ash), of each lb. ij.; Boiling Water, *Cong.* vj. Add first the lime, then the pearlashes, and afterwards the woodashes, to the boiling water; then mix. In twenty-four hours the clear liquor may be drawn off.—In this process the lime decomposes the carbonate of potash contained in pearlashes and woodashes, and combines with the carbonic acid, setting free the potash. The liquid, therefore, is a solution of caustic potash contaminated with some soluble alkaline salts (sulphate of potash and chloride of potassium). The solution is stronger than the officinal *liquor potassæ,* but is liable to vary in strength, in consequence of the varying quality of the ashes used.—Dose, according to Mr. Brandish, for an adult, is three (or even four) teaspoonfuls; for children of from four to six years of age, one small teaspoonful; from six to eight years, a teaspoonful and a half; from eight to fifteen, two teaspoonfuls; and from fifteen to eighteen years, two teaspoonfuls and a half. The dose is to be taken twice daily, between breakfast and dinner and at bed-time, in fresh small beer or ale. A drop or two of oil of juniper covers the saponaceous taste, and gives a grateful smell. A generous regimen, and a careful avoidance of acids, were employed by Mr. Brandish in conjunction with the alkaline liquor. In scrofulous tumours, mercurial ointment was rubbed in.

2. POTASSÆ HYDRAS, Ph. L.; *Potassa,* Ph. Ed.; *Potassa Caustica,* Ph. Dub.; *Potassa fusa; Kali purum; Lapis infernalis vel septicus; Cauterium potentiale.*—All the British Colleges give directions for the preparation of hydrate of potash.

The *London College* orders, of Solution of Potash, a gallon. Evaporate the water in a clean iron vessel over the fire, until, the ebullition being finished, the hydrate of potash liquefies: pour this into proper moulds.

The *Edinburgh College* directs any convenient quantity of Aqua Potassæ to be evaporated in a clean and covered iron vessel, increasing gradually the heat till an oily-looking fluid remains, a drop of which, when removed on a rod, becomes hard on cooling; then pour out the liquid upon a bright iron plate, and as soon as it solidifies break it quickly, and put it into glass bottles secured with glass stoppers.

The process of the *Dublin College* is essentially the same as that of the Edinburgh College, except that the evaporation is to be effected in vessels of silver or iron, and the liquefied potash is to be poured out on a plate of silver or iron.

"During the preparation of the hydrate of potash, a portion of the potash becomes converted by the high temperature and under access of air to peroxide of potassium; the additional oxygen thus acquired is expelled in the gaseous state during solution in water" (*R. Phillips*).

The solid hydrate of potash of the shops, commonly called *potassa fusa*, is usually found in the shops in sticks (*potassa fusa in baculis*). It is in general more or less coloured (brownish, greyish, or bluish), and not completely soluble in water and alcohol, in consequence of the presence of foreign matters. Pure hydrate of potash, however, is white, and dissolves in both water and alcohol. During its solution in water, heat is evolved. Its solubility in alcohol enables us to separate it from the carbonate and bicarbonate of potash, both of which are insoluble in this liquid. When purified by solution in alcohol, it constitutes the *potasse à l'alcool* of the French writers. It has a strong affinity for both water and carbonic acid, which it rapidly attracts from the atmosphere, and in consequence becomes liquid. At a low red heat it fuses, and at a higher temperature is volatilised. It is odourless, but has a caustic, urinous taste. It rapidly decomposes organic substances. It possesses the properties of an alkali in an eminent degree.

Its composition is as follows:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Berzelius.*
Potash	1	47	83·93	84
Water	1	9	16·07	16
Hydrate of Potash	1	56	100·00	100

Potassa fusa of the shops contains various impurities, such as sesquioxide of iron, oxide of manganese, carbonate of potash, and silica. These, however, do not materially affect its medicinal value.

"Boiling water commonly leaves oxide of iron undissolved, which should not exceed 1·25 per cent.: the solution neutralised with nitric acid gives a faint precipitate with a solution of nitrate of baryta, and more with solution of nitrate of silver, owing to the presence of impurities."—*Ph. Ed.*

The nitrate of baryta detects sulphates, while nitrate of silver is a test for chlorides.

Hydrate of potash is exclusively employed as an escharotic. For some purposes its deliquescent property renders it inferior to nitrate of silver.

[Dr. Malapert has employed topically a solution of hydrate of potash in inflammatory affections of the mucous membranes and skin. Its effects have been the "disgorgement" of the inflamed surface by the production of a serosanguineous exudation. This exudation exerts a healthy influence upon and alters the action of ulcers of the mucous surfaces. Applied to the external skin, its action is vesicant, exerting a powerfully modifying action on cutaneous inflammation.[1]—ED.]

---

[1] *Bulletin Thérapeut.* tom. xxxvi. p. 136.

3. POTASSA CUM CALCE, L. E.; *Potassa Caustica cum Calce*, D.; *Causticum commune fortius; Potash with Lime*.—It is sometimes called by continental writers, *Pasta escharotica Londinensis*. A compound of potash and lime was used as a caustic by the Greeks under the name of πρωτόστακτον.[1] It was probably identical with *calx liquefacta vulgo colata* of Cælius Aurelianus.[2]

The following are the directions for preparing Potassa cum calce:—

According to the *London College*, Hydrate of Potash, and Lime, of each an ounce, are to be rubbed together, and kept in a well-stoppered vessel.

The *Edinburgh College* directs that any convenient quantity of Aqua Potassæ be evaporated in a clean covered iron vessel to one-third of its volume; add slaked lime till the fluid has the consistence of firm pulp: preserve the product in carefully-covered vessels.

The process of the *Dublin College* is similar to that of the London College.

By admixture with lime, hydrate of potash is rendered less deliquescent. Potassa cum calce is employed as an escharotic in the same cases as potassa fusa. When used, it may be made into a paste with rectified spirit, and applied to the part to be cauterised; or it may be used in the form of sticks as recommended by Dr. H. Bennett.

When mixed with water it is slaked, and when any acid is added no bubbles of carbonic acid escape.—*Ph. Lond.*

The *pulvis causticus* seu *escharoticus Viennensis* is composed of five parts of fused potash and six parts of caustic lime.

42. POTASSÆ CARBONATES.—CARBONATES OF POTASH.

HISTORY.—Two compounds of potash and carbonic acid are well known, and are employed in medicine. They are—

1. The Monocarbonate, or neutral carbonate of potash	KO,CO^2.
2. The Bicarbonate of potash	$KO,2CO^2$.

A third, or sesquicarbonate, has been described, but its existence is problematical. The monocarbonate was known to the ancients, though the real distinction between it and caustic potash was first explained by Dr. Black, in 1756. The bicarbonate was first obtained in 1757.

EFFECTS.—The general effects of the carbonates of potash are similar to, though milder than, those of caustic potash; and they are milder in proportion to the quantity of carbonic acid which they contain.

1. Potassæ Monocarbonas.—Neutral Carbonate of Potash.

Formula KO,CO^2. *Equivalent Weight* 69.

HISTORY.—It is probable that the ancient Greeks, Romans, and Egyptians were acquainted with this salt. Pliny[3] describes some of the uses of wood-ashes, and mentions a lye of them (*cinis lixivius*). For a long period carbonate of potash was confounded with carbonate of soda. Geber,[1] in the eighth century, describes the method of procuring it by the combustion of tartar.

---

[1] Paulus Ægineta, Adams's translation, vol. i. pp. 414 and 428; vol. ii. p. 265; vol. iii. p. 185.

[2] *Morb. Chron.* lib. v. cap. i. p. 554, ed. J. C. Amman, Amstel. 1722.

[3] *Hist. Nat.* lib. xiv. and xxviii.

SYNONYMES.—In chemical and pharmaceutical works it is usually called *carbonate of potash* (*potassæ carbonas*, L. E. D.); but until very recently it was generally termed *subcarbonate of potash* (*potassæ subcarbonas*). It was formerly called *mild fixed vegetable alkali* or *prepared kali* (*kali præparatum*). According to the source from which it was obtained, or the mode of procuring it, it has had the various names of *salt of tartar* (*sal tartari*), *salt of wormwood* (*sal absinthii*), *salt of broom* (*sal genistæ*), *fixed nitre* (*nitrum fixum*), *white flux* (*fluxus albus*), &c.

NATURAL HISTORY.—Reuss[2] found carbonate of potash in the waters of the Wuissokow and in the chalybeate of Twer.

It is formed, during the combustion of inland plants, by the decomposition of the vegetable salts of potash (the acetate, the malate, and the oxalate, but principally the first). Hence it is procured in great abundance from wood-ashes. In some few cases it has been supposed to exist ready formed in plants, as in a fern referred to by Mr. Parkes,[3] the expressed juice of which is employed by the poor weavers of Yorkshire in the cleansing of cloth at the fulling mills.

PREPARATION. *α*. **Of Potashes and Pearlashes** (*Lixivus Cinis*, Ph. D.)—These are obtained from *wood-ashes* (*cineres vegetabilium* seu *cineres e lignis combustis*), which are procured by burning wood piled in heaps on the ground, sheltered from the wind, or in pits.[4] The soluble constituents of the ashes are *carbonate, sulphate, phosphate, and silicate of potash, and chlorides of potassium and sodium*. The insoluble constituents are *carbonate and subphosphate of lime, alumina, silica, the oxides of iron and manganese, and a dark carbonaceous matter*. In America the ashes are lixiviated in barrels with lime, and the solution evaporated in large iron pots or kettles, until the mass has become of a black colour and of the consistence of brown sugar. In this state it is called by the American manufacturers, *black salts* (*cineres clavellati crudi*). The dark colour is said by Dumas to be owing to *ulmate of potash*.

To convert this substance into the *potashes* of commerce (*cineres clavellati calcinati*), it is heated for several hours, until the fusion is complete, and the liquid becomes quiescent. It is then transferred by large iron ladles into iron pots, where it congeals in cakes. These are broken up, packed in tight barrels, and constitute the *potashes* of commerce. Its colour varies somewhat, but it is usually reddish, in consequence of the presence of sesquioxide of iron.

To make the substance called *pearlash*, the mass called black salts, instead of being fused, is transferred from the kettles to a large oven-shaped furnace, constructed so that the flame is made to play over the alkaline mass, which in the meantime is stirred by means of an iron rod. The ignition is in this way continued until the combustible impurities are burnt out, and the mass, from being black, becomes dirty bluish-white, having somewhat of a pearly lustre, whence the name *pearlash*.[1] The colouring matter is probably in this case manganate of potash.

---

[1] *Invent. of Verity*, ch. iv.

[2] Gairdner, *On Mineral Springs*, p. 18.

[3] *Chemical Essays*, vol. ii. p. 17.

[4] For an account of the preparation and composition of wood-ashes, see Berthier, *Traité des Essais*, t. i. p. 259, Paris, 1834.

The following table shows the composition of various kinds of potash and pearlash according to Vauquelin :[2]—

Kinds of Potash.	Caustic Hydrate of Potash.	Sulphate of Potash.	Chloride of Potassium.	Insoluble Residue.	Carbonic Acid and Water.
American Potash	857	154	20	2	119
Russian Potash..................	772	65	5	56	254
American Pearlash	754	80	4	6	308
Potash of Trèves	720	165	44	24	199
Dantzic Potash..................	603	152	14	79	304
Potash of Vosges	444	148	510	34	16

In this table it will be observed that the American potash contains the largest quantity of caustic potash : this arises, probably, from the use of lime in its manufacture.

Pearlash contains more carbonate of potash than potashes : this must arise from the absorption of carbonic acid during its preparation.[3] The potash and pearlash employed in this country are principally imported from the British North American colonies, from Russia, and from the United States of America.

β. **Of Refined Potashes**; *Potassæ Carbonas*, L. E.; *Potashes*, E.; *Potassæ Carbonas e Lixivo Cinere*, D.—The Dublin College gives directions for the preparation of this substance.

The *Edinburgh College* merely states that this preparation is "Carbonate of Potash not quite pure, obtained by lixiviating, evaporating, and granulating by fusion and refrigeration the potashes of commerce."

The *Dublin College* directs of Pearlash, ten pounds; Distilled Water, one gallon. Pour the water on the pearlash, and macerate for a week, occasionally stirring the mixture. Filter through calico, and, having evaporated the solution nearly to dryness, reduce the heat and stir constantly with an iron rod until granular crystals are obtained. Let these be immediately enclosed in well-stopped bottles.

γ. **Of Pure Carbonate of Potash**; *Potassæ Carbonas purum*, E. D.—Two of the British Colleges give directions for the preparation of this substance.

The *Edinburgh College* observes, that Pure Carbonate of Potash may be most readily obtained by heating crystallised Bicarbonate of Potash to redness in a crucible, but more cheaply by dissolving Bitartrate of Potash in thirty parts of boiling water, separating and washing the crystals which form on cooling; heating these in a loosely-covered crucible to redness so long as fumes are discharged; breaking down the mass and roasting it in an open crucible for two hours, with occasional stirring, lixiviating the product with distilled water, filtering the solution thus obtained, evaporating the solution to dryness, granulating the salt towards the close by brisk agitation, and heating the granular salt nearly to redness. The product of either process must be kept in well-closed vessels.

The process of the *Dublin College* is as follows :—

---

[1] *United States Dispensatory.*

[2] *Ann. de Chim.* xl. 273.

[3] For the mode of estimating the quantity of alkali present, see Mr. Faraday's *Chemical Manipulation*, art. *Alkalimetry*; also Brande's *Manual of Chemistry*, 6th edit. vol. i. p. 593.

Take of White Bitartrate of Potash, two pounds; Sesquicarbonate of Ammonia, half an ounce; Distilled Water, three pints. Place the bitartrate of potash in an iron pot or crucible, and, constantly stirring it with an iron rod, expose it to a red heat until vapours cease to be evolved. Reduce the residuum to a coarse powder, and, having boiled it for twenty minutes with one quart of the water, filter through paper, washing the filter and its contents with the residual pint of water, in which the sesquicarbonate of ammonia has been first dissolved. The filtered solution is now to be evaporated to dryness, and, a low red heat being finally applied, the product is to be rapidly reduced to powder in a warm mortar, and enclosed in well-stopped bottles.

In the London Pharmacopœia this salt has now been transferred to the Materia Medica.

When bicarbonate of potash is submitted to a low red heat, it loses half its carbonic acid, and is converted into the carbonate.

When bitartrate is ignited, various volatile substances are evolved, and the residue in the crucible is a mixture of charcoal and carbonate of potash, and is denominated *black flux* (*fluxus niger*). "If made with raw tartar, which contains nitrogen, it is contaminated with bicyanide of potassium" (Turner). By roasting, the charcoal is burnt off, and nearly pure carbonate of potash is obtained from the residue by lixiviation. The carbonate thus produced is called *salt of tartar* (*sal tartari*). It is comparatively pure.

By deflagrating a mixture of equal parts of bitartrate of potash and nitrate of potash we obtain bitartrate of potash contaminated with hyponitrite and even with some undecomposed nitrate of potash. The residue is called *white flux* (*fluxus albus*).

By deflagrating a mixture of nitre and charcoal we obtain what is called *fixed nitre* (*nitrum fixum*).

The high price of pearlash has occasionally led to the manufacture of carbonate of potash from *sal enixum* (bisulphate of potash), by heating it in a reverberatory furnace with charcoal. This yields a sulphuret of potassium, in consequence of the carbon deoxidising the bisulphate. By roasting, this sulphuret is decomposed, and converted into carbonate of potash; the sulphur being dissipated, and the potassium combining with oxygen and carbonic acid.

[Mr. Spence, of Manchester, has improved upon the process of procuring carbonate of potash, by passing carbonic acid into solutions of sulphuret of barium and sulphate of potash at the ordinary temperature, having previously raised the temperature of the gas to 200° Fahr. By this means the decomposition is effectually accomplished. The sulphate of baryta deposited may be reconverted into sulphuret of barium with carbonaceous matter in the usual way.[1]—ED.]

PROPERTIES.—Carbonate of potash is usually kept, in the shops, in a granular condition, on account of the difficulty of crystallising it. In this state it is commonly denominated *subcarbonate of potash* (*potassæ subcarbonas*) or *salt of tartar* (*sal tartari; sal absinthii; kali præparatum*). It is white, inodorous, and strongly alkaline to the taste. It reacts powerfully as an alkali on turmeric. It changes the red colour of the sulphate of red cabbage to a blue and green, and restores the blue colour of reddened litmus. It is fusible at a red heat; has a strong affinity for water, so that by exposure to the air it attracts water and becomes liquid, forming the *oleum tartari per deliquium*. It is insoluble in alcohol, but is very soluble in water.

---

[1] For further details, see *Pharmaceutical Journal*, 1851, page 607.

Pure carbonate of potash may, though with some difficulty, be crystallised from its aqueous solution. The crystals are rhombic octahedrons, and belong to the right prismatic system.

Characteristics.—It is known to be a carbonate by its effervescing with the strong acids, and by a solution of it causing a white precipitate (soluble in acetic acid) with lime-water or with chloride of barium (see the tests for the *carbonates,* p. 330). That it is a potash salt is determined by the tests for potash which have been already mentioned. From the bicarbonate of potash it is distinguished by a solution of perchloride of mercury causing a brick-red precipitate. The presence of chloride of sodium checks or prevents the formation of this precipitate. Sulphate of magnesia produces a white precipitate with the carbonate of potash, and not with the bicarbonate. This test, however, will not recognise the carbonate when mixed with a large quantity of bicarbonate.

Composition.—Pure anhydrous carbonate of potash has the following composition:—

	Atoms.	*Eq. Weight.*	*Per Cent.*	*Vanquelin.*	*Ure.*
Potash	1	47	68·12	67	68·6
Carbonic acid	1	22	31·88	33	31·4
Neutral Carbonate of Potash	1	69	100·00	100	100·0

According to Mr. Phillips,[1] the granulated carbonate of potash of the shops contains about 16 per cent. of water, which it loses when heated to redness. The crystallised salt contains two atoms of water, while the salt of the Materia Medica is a sesquihydrate.

	At.	*E.Wt.*	*P.Ct.*	*Phillips.*
Carbonate of potash	1	69	83·64	84
Water	1½	13·5	16·36	16
Granulated Carb. of Potash	1	82·5	100·00	100

	At.	*E.Wt.*	*P.Ct.*	*Phillips*
Carbonate of potash	1	69	79·31	79
Water	2	18	20·69	21
Crystallised Carb. of Potash	1	87	100·00	100

In this table I have assumed the granulated carbonate of potash to be pure, which the salt of commerce never is.

Impurities.—The ordinary impurities in this salt are water, silicic acid, the chlorides and sulphates. The first is detected by the loss of weight which the salt suffers by heat; the second is recognised by supersaturating with hydrochloric acid, evaporating, and igniting the residue: the silicic acid is insoluble in water. The other impurities are detected by supersaturating the salt with nitric acid: if the resulting solution give a white precipitate with nitrate of silver, the presence of a chloride is to be inferred; if it produce a white precipitate with chloride of barium, a sulphate is present. [If, before saturation with nitric acid, nitrate of silver gives with the solution a brown precipitate (oxide of silver), this would indicate the presence of free alkali.—Ed.] Other impurities mentioned by L. Gmelin are phosphate of potash, nitrate or hyponitrite of potash, cyanide of potassium, soda, and carbonate of lime. To detect the phosphate, boil with excess of hydrochloric acid to expel all the carbonic acid: then add some chloride of calcium and excess of caustic ammonia: a flocculent precipitate of phosphate of lime is formed. If nitrate or hyponitrite be present, dissolve in oil of vitriol and add a solution of sulphate of iron, when a reddening is perceived. Cyanide of potassium is detected by adding a solution of the mixed sulphates of iron, and then hydrochloric acid: prussian blue is formed. To detect soda, saturate with acetic acid, evaporate to dryness, dissolve the residue in spirit of wine, and precipitate the potash by bichloride of platinum: add sulphuric acid to the filtered liquor and evaporate, and ignite the residue: then treat with water, evaporate the solution thus obtained, and by cooling easily recognised crystals of sulphate of soda are obtained. [The soda may be more readily detected by converting it to common salt by hydrochloric acid, and noticing the cubic form of the crystal and the intense yellow colour given by it to the flame of alcohol.—ED.] Some carbonate of lime is held in solution by carbonate of potash, but by long standing it is deposited. To detect it, saturate with acetic acid, and then add oxalic acid; a white precipitate of oxalate of lime is obtained.

---

[1] *Translation of the Pharmacopœia,* p. 344, 1851.

The *London College* states the following to be the characters of good carbonate of potash:—

> Deliquesces in the air: almost entirely soluble in water. This solution changes the colour of turmeric to brown. When supersaturated with nitric acid, neither carbonate of soda nor chloride of barium throws down anything, and nitrate of silver very little, if any. 100 grains lose 16 grains of water by exposure to a strong heat; and the same quantity loses 26·3 grains of carbonic acid on the addition of dilute sulphuric acid. Let it be kept in a well-stopped vessel.—*Ph. Lond.*

The *Edinburgh College* states that

> "100 grains [*of commercial carbonate of potash*] lose not more than 20 on exposure to a red heat: and when dissolved and supersaturated by pure nitric acid, the solution gives a faint haze with solution of nitrate of baryta, and is entirely precipitated by 100 minims of solution of nitrate of silver."—*Ph. Ed.*
>
> *Pure Carbonate of Potash* "does not lose weight at a low red heat: and a solution supersaturated with pure nitric acid is precipitated either faintly, or not at all, by solution of nitrate of baryta or nitrate of silver."

PHYSIOLOGICAL EFFECTS.—Its effects are in *quality* precisely those of caustic potash already described, but their *intensity* is much less, on account of the presence of carbonic acid, which diminishes the alkaline properties of the base. When it is taken into the stomach in large quantities, it acts as a powerfully caustic poison, sometimes inducing death in twelve hours, and producing symptoms of irritation somewhat resembling those caused by the mineral acids: at other times, however, the patient recovers from the immediate effect of the alkali, but, in consequence of the altered condition of the alimentary canal, the assimilative process cannot be carried on; and, after dragging on a miserable existence for a few weeks, the unfortunate sufferer dies of absolute starvation. And lastly, in some cases the caustic operation of the poison is principally confined to the œsophagus, causing stricture and death. In a case related by Sir Charles Bell,[1] a patient swallowed soap lees, which produced inflammation, terminating in stricture. She lingered for twenty years, and died literally starved. Several other cases have been detailed.[2] In one case no vomiting occurred, but death took place from suffocation.[3] A weak solution of carbonate of potash produces no change in the sanguineous particles drawn from the body: a saturated solution slightly and gradually diminishes their size.

---

[1] *Surgical Observations*, part i. p. 82.

[2] Christison, *On Poisons*.

[3] *Lancet*, 1834–5, vol. ii. p. 660.

Uses.—This salt is employed, in medicine, in most of the cases already mentioned when describing the uses of caustic potash. For example, as an antacid in dyspeptic affections; as a diuretic; as an antacid in that form of lithiasis which is accompanied with an increased secretion of lithic acid, or the lithates; in those forms of inflammation in which there is a tendency to the formation of false membranes; in gout, &c. On the recommendation of Mascagni,[1] it has been employed in peripneumonia, and other inflammatory diseases with benefit. Mixed with cochineal, it is a popular remedy for hooping-cough. Externally it has been applied in the form of a solution to wounds; as an injection in gonorrhœa, and as a collyrium in some affections of the cornea. Lastly, it is sometimes employed in the manufacture of the common effervescing draught, made with either the citric or tartaric acid.

20 grs. of Carbonate of Potash are saturated by about { 17 grs. of commercial crystals of Citric Acid,
18 grs. of crystals of Tartaric Acid,
4 fluidrachms of Lemon Juice.

Administration.—It may be given either in the solid or liquid state. In the solid state it is given in doses of from gr. x. to ʒss.

Antidotes.—When swallowed as a poison, the antidotes are oils or acids, as already mentioned for caustic potash.

LIQUOR POTASSÆ CARBONATIS, L.; *Potassæ Carbonatis Liquor*, D.; *Aqua Kali; Solution of Carbonate of Potash; Liquamen Tartari*, seu *Oleum Tartari per deliquium; Lixivium Tartari; Aqua Kali præparati; Liquor Potassæ Subcarbonatis.* (Carbonate of Potash, ℥xx.; Distilled Water, Oj. dissolve and strain, *L.*); (Pure Carbonate of Potash, ℥x.; Distilled Water, Oj. Dissolve and filter. The sp. gr. of this solution is 1·310, *D.*)—A colourless, inodorous solution. Prepared according to the London Pharmacopœia, its sp. gr. is 1·473. That of the Dublin College is 1·310.—Dose, ♏x. to f℥j.

2. Potassæ Bicarbonas.—Bicarbonate of Potash.

Formula $KO,2CO^2,HO$. *Equivalent Weight* 100.

History.—This salt, formerly called *carbonate of potash* or *aërated kali*, was first prepared by Cartheuser, in 1757. It is sometimes called *Berthollet's neutral carbonate of potash.* Wollaston first demonstrated that this salt contained twice as much acid as the preceding one.

Preparation.—The London College has removed this compound to the Materia Medica. The two other British Colleges give directions for its preparation. The process of the *Dublin College* is based on a recent improvement for the manufacture of this salt:—

Take of Carbonate of Potash from Pearlash, one pound; Distilled Water, one quart; Muriatic Acid of commerce, one pint and a half; Water, three pints; Chalk in small fragments, one pound, or a sufficient quantity. Dilute the muriatic acid with the water, and having dissolved the carbonate of potash in *distilled* water, filter the solution into a three-pint bottle capable of being tightly closed by a cork traversed by a glass tube sufficiently long to pass to the bottom of the solution. A second bottle, in the bottom of which a few holes are drilled, and the mouth of which admits of being closed by a cork also traversed by a glass tube, having been filled with the chalk, and placed in a glass or porcelain jar of the same height with itself, but of somewhat larger diameter, the exterior ends of the two tubes are to be connected *air-tight* by a tube of vulcanised Indian rubber. The cork of the bottle containing the carbonate of potash being placed *loosely*, and that of the other bottle *tightly* in its place, and the muriatic acid having been poured into the jar in which is lodged the perforated bottle containing the chalk, the liberation of carbonic acid commences; and as soon as it is judged that a sufficient amount of it has been developed to expel completely the air from the apparatus, the cork of the carbonate of potash bottle is to be forced in quite tight, and the process is to be abandoned to itself for a week. At the end of this time numerous crystals of the bicarbonate of potash will have formed, which are to be removed, shaken in a capsule with twice their bulk of cold water, which is to be rapidly decanted, next drained, and finally dried on bibulous paper by mere exposure to the atmosphere. The mother-liquor, if filtered, and concentrated to one-half, at a temperature not exceeding 110°, will yield additional crystals.

---

[1] *Memoria della Società Italiana della Scienze,* t. xi. Modena, 1804; Negri, *Lond. Med. Gaz.* vol. xiv. p. 713.

The tube immersed in the solution of carbonate of potash will have to be occasionally cleared of the crystals with which it is liable to become plugged, else the process will be suspended.

In this process each equivalent of carbonate of potash unites with an additional equivalent of carbonic acid, and thereby forms the bicarbonate. The silicic acid is separated partly while the carbonic acid is passing through the solution, and partly during the crystallisation of the bicarbonate.

At Apothecaries' Hall, London, the process is conducted in two iron vessels; in one of which carbonic acid is generated (by the action of sulphuric acid on whiting), in the other is contained the solution of carbonate of potash, through which the carbonic acid is passed. "The following proportions may be used for the preparation of bicarbonate of potassa upon the large scale:—100 lbs. of purified carbonate of potassa are dissolved in 17 gallons of water, which, when saturated with carbonic acid, yield from 35 to 40 lbs. of crystallised bicarbonate; 50 lbs. of carbonate of potassa are then added to the mother-liquor, with a sufficient quantity of water to make up 17 gallons, and the operation repeated (*Hennell*)."[1] Sulphuric is preferable to muriatic acid for generating carbonic acid, as being both cheaper and less volatile. [The volatility is prevented by a proper degree of dilution, as in the process of the Dublin College. The sulphate of lime formed when sulphuric acid is used, is a pasty insoluble compound which absorbs water, coats the carbonate of lime, and tends to arrest chemical action. The escape of a little hydrochloric acid would have only the effect of producing a little chloride of potassium in the bicarbonate. From this the bicarbonate would be separated by crystallisation.—ED.]

The *Edinburgh College* directs it to be prepared from Carbonate of Potash, ℥vj.; and Carbonate [Hydrated Sesquicarbonate] of Ammonia, ℥iiiss. Triturate the Carbonate of Ammonia to a very fine powder; mix with it the Carbonate of Potash; triturate them thoroughly together, adding by degrees a very little Water, till a smooth and uniform pulp be formed. Dry this gradually at a temperature not exceeding 140°, triturating occasionally towards the close, and continue the desiccation till a fine powder be obtained, entirely free of ammoniacal odour.

In this process the volatility of the ammonia and the affinity of the carbonate of potash for more carbonic acid, cause together the decomposition of the sesquicarbonate of ammonia: the ammonia, with a small portion of carbonic acid, is disengaged, while the remaining acid converts the carbonate into the bicarbonate of potash. The process adopted by the Edinburgh College is that commonly known as *Cartheuser's process.* MM. Henry and Guibourt[1] give the following directions for its performance:—

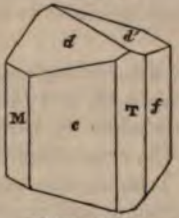
---

[1] Brande, *Manual of Chemistry*, 6th edit. p. 598.

Dissolve 500 parts of (pure) carbonate of potash in 1000 parts of distilled water, and filter; place the solution in a porcelain vessel in a salt-water bath, and gradually add 300 parts of pulverised carbonate of ammonia; slightly agitate the liquor until only a feeble disengagement of ammonia is perceived, then filter over a heated vessel, and put aside to cool. The proportions employed by Geiger[2] are somewhat different: they are—a pound of carbonate of potash, sixteen ounces of water, and six ounces of carbonate of ammonia.

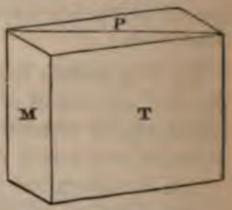
Properties.—It is a crystalline, colourless solid. The crystals belong to the oblique prismatic system. The primary form is, according to Mr. Brooke,[3] a right oblique-angled prism. It is inodorous, has an alkaline taste, and reacts very feebly as an alkali on vegetable colours. It is soluble in four times its weight of water at 60° F., but is insoluble in alcohol. When exposed to the air, it undergoes no change. When exposed to a red heat, it gives out half its carbonic acid, and becomes the carbonate.

Fig. 76.



Modified Prism of Carbonate of Potash.

Fig. 77.



Prism derived by Cleavage.

Characteristics.—The presence of carbonic acid and potash in this salt is known by the tests for these substances before mentioned. From the carbonate of potash it is best distinguished by a solution of perchloride of mercury, which causes only a slight white precipitate or opalescence with it; whereas with the carbonate it causes a copious brick-red precipitate. This test, however, will not, under all circumstances, detect the carbonate; as when the quantity is very small, or when chloride of sodium is present. Sulphate of magnesia, which precipitates the carbonate, gives no precipitate with the bicarbonate until the mixture has been boiled. Neither this nor any other test will prove the total absence of carbonate.

Composition.—The composition of this salt is as follows:—

	Atoms.	*Eq. Wt.*	*Berard.*	*Vauquelin.*
Potash	1	47	48·92	46
Carbonic acid	2	44	42·01	47
Water	1	9	9·07	7
Crystallised Bicarbonate of Potash	1	100	100·00	100

Impurities.—The presence of chlorides and sulphates may be recognised in this salt as in carbonate of potash (see *ante*, p. 491). Perchloride of mercury may be employed to detect carbonate of potash, with which it forms a brick-red coloured precipitate.

---

[1] *Pharmacopée Raisonnée*, 3me éd. p. 605, Paris, 1841.

[2] *Handbuch der Pharmacie*, 3tte Aufl.

[3] *Annals of Philosophy*, N. S. vol. vi. p. 42; also Levy, in *Quarterly Journal of Science*, vol. xv.

Deliquesces in air. The solution changes the colour of turmeric to red brown. When neutralized by nitric acid, carbonate of soda and chloride of barium throw down nothing, and nitrate of silver gives only a very faint precipitate. 100 grains of the salt exposed to a strong heat lose only 16 grains of water, and the same quantity added to diluted sulphuric acid evolve 26·3 grains of carbonic acid. It should be kept in a well-closed (green glass) bottle.—*Ph. Lond.*

A solution in 40 parts of water does not give a brick-red precipitate with solution of corrosive sublimate; and when supersaturated with nitric acid, is not affected by a solution of nitrate of baryta or nitrate of silver.—*Ph. Ed.*

PHYSIOLOGICAL EFFECTS.—The effects of this salt are similar to those of the carbonate of potash, except that its local action is much less energetic, in consequence of the additional equivalent of carbonic acid. Hence it is an exceedingly eligible preparation in lithiasis and other cases where we want its constitutional, and not its local, action.

[The neutral salts of potash, combined with vegetable acids, according to Wöhler undergo oxidation in the blood, and are transformed into bicarbonates.

Thus the neutral (bibasic) tartrate of potash may, with the addition of ten atoms of oxygen, produce two equivalents of bicarbonate of potash, together with four of carbonic acid and four of water.

$$\begin{aligned} 2KO,C^8H^4,O^{10} + 10O &= \overline{2KO + 8CO^2} + 4HO \\ &= \overline{2(KO,2CO^2)} + (4CO^2 + 4HO) \end{aligned}$$

This carbonate, easily decomposed by any acid, is equivalent to a free alkali. Thus these salts fulfil a double function. They may supply the respiratory process; they may also act on the blood and on the secretions like alkalies.[1]—ED.]

USES.—It may be employed for the same purposes as caustic potash, except that of acting as an escharotic. Thus it is used as an antacid, to modify the quality of urine, in plastic inflammation, in glandular diseases and affections of the urinary organs. It is the active ingredient of a popular lithonlytic called *constitution water*. But its most frequent use is that for making effervescing draughts, with either citric or tartaric acid. The proportions are as follows:—

20 grs. of crystallised Bicarbonate of Potash are saturated by about	14 grs. of commercial crystals of Citric Acid, 15 grs. of crystallised Tartaric Acid, 3½ drachms of Lemon Juice.

Where there is great irritability of stomach, I believe the effervescing draught, made with bicarbonate of potash and citric acid, to be more efficacious than that made with carbonate of soda and tartaric acid. The citrate of potash which is formed promotes slightly the secretions of the alimentary canal, the cutaneous transpiration, and the renal secretion; and, like other vegetable salts of potash, renders the urine alkaline.

ADMINISTRATION.—This salt may be given in doses of from gr. x. to gr. xv., or to the extent of half a drachm, or even a drachm.

1. POTASSÆ AQUA EFFERVESCENS, E.; *Effervescing Solution of Potash;*

---

[1] Headland, *On the Action of Medicines*, p. 114.

Potash Water. (Bicarbonate of Potash, ʒj.; Distilled Water, Oj. Dissolve the salt in the water, and transmit through the solution Carbonic Acid Gas under strong pressure. Keep the solution in a well-stoppered vessel.)—This is a solution of bicarbonate of potash surcharged with carbonic acid. It is an agreeable mode of exhibiting bicarbonate of potash, without injuring its medicinal power. It may be extemporaneously imitated by pouring a bottle of soda-water (i. e. *carbonic acid water*) into a tumbler containing grs. xx. of bicarbonate of potash.

[This compound was formerly introduced into the London Pharmacopœia under the name of *Liquor Potassæ Effervescens*. The solution is now very extensively employed as a diet-drink; and one of the most convenient apparatuses for preserving the water for constant use is the syphon vase patented by Mayo and Watson. In this the water is constantly under pressure, and any quantity can be drawn without removing the carbonic acid from that which remains.—ED.]

2. **LEMON AND KALI.**—Under this name is kept in the shops a mixture professedly composed of powdered white sugar, dried and powdered citric acid, and powdered bicarbonate of potash; but on account of its deliquescence the citric acid is usually replaced by tartaric acid. This mixture is employed as an extemporaneous effervescing draught. As it abstracts water from the atmosphere, it must be preserved in a well-stoppered bottle (see *Pulveres Effervescentes*, Ph. Ed. and Dubl.; also *Sodæ Bicarbonas*, post).

43. POTASSII TERSULPHURETUM.—TERSULPHURET OF POTASSIUM.

Formula KS^3. *Equivalent Weight* 87.

HISTORY.—Geber[1] was acquainted with the solubility of sulphur in an alkaline solution; but Albertus Magnus taught the method of procuring sulphuret of potassium by fusion. The preparation kept in the shops under the name of *sulphuret of potassium* (*potassii sulphuretum*, L. E.) or *liver of sulphur* (*hepar sulphuris*, D.) is a mixture of tersulphuret of potassium (to which it owes its essential properties) and some oxysalts of potash.

PREPARATION.—The process for the preparation of this compound in the Edinburgh Pharmacopœia is as follows:—

Take of Sulphur, ℥j.; Carbonate of Potass, ℥iv. Triturate them well together, and heat them in a covered crucible, until they form a uniform fused mass, which, when cold, is to be broken into fragments and kept in well-closed vessels.

The following is the Dublin process:—

Take of Sublimed Sulphur, four ounces; Carbonate of Potash from Pearlash, first dried, and then reduced to powder, seven ounces. Mix these ingredients in a warm mortar, and having introduced them into a Hessian crucible, let this be heated, first gradually, until effervescence has ceased, and finally to low redness, so as to produce perfect fusion, and let its liquid contents be then poured into an iron cup, over which a second vessel should be immediately inverted, so as to exclude the air as completely as possible, while solidification is taking place. The solid product thus obtained should, when cold, be broken into fragments, and immediately enclosed in a green glass bottle, furnished with an air-tight stopper.

---

[1] *Invention of Verity*, chap. vi.

When sulphur and commercial carbonate of potash are fused together, water and carbonic acid are evolved. Part of the potash is decomposed, its potassium combining with sulphur to form a sulphuret of potassium; while its oxygen unites with sulphur to form one or more acids which combine with some undecomposed potash. A portion of the carbonate of potash remains undecomposed.

Assuming with Berzelius that a tersulphuret of potassium and sulphate of potash are produced, the following equation represents the changes:—$10\ S + 4(KO,CO^2) = 3(KS^3) + KO,SO^3 + 4CO^2$. The excess of carbonate of potash employed is presumed to remain unchanged.

PROPERTIES.—When fresh prepared, it has a liver-brown colour; and hence the common name *hepar sulphuris*. Its taste is acrid, bitter, and alkaline. If quite dry it is inodorous, but when moistened it acquires the odour of hydrosulphuric acid. Exposed to the air it undergoes decomposition, from the action of aqueous vapour and oxygen. It becomes green and moist, and ultimately whitish. This change depends on the absorption of oxygen, in consequence of which part of the sulphur is deposited, while a portion of the sulphuret of potassium is converted into hyposulphite, afterwards into sulphite, and ultimately into sulphate of potash. Sulphuret of potassium is soluble in water, and the solution has a strong alkaline reaction.

Characteristics.—Hydrochloric acid causes the evolution of hydrosulphuric acid gas, and the precipitation of sulphur; the solution of the sulphuret in water produces a reddish or black precipitate with a solution of lead. That it contains potassium may be determined thus:—Add excess of hydrochloric acid to a solution of it; boil, and filter. The tests for potash may then be applied.

Fresh broken, it exhibits a brownish-yellow colour. Dissolved in water, or acids, it evolves the odour of hydrosulphuric acid. The aqueous solution is of a yellow colour. [It throws down a red precipitate from acetate of lead, which soon becomes black. By exposure to the air, or by long keeping in imperfectly stoppered vessels, it absorbs oxygen, and being converted into sulphate of potash becomes nearly colourless, sparingly soluble in water, emits no smell of hydrosulphuric acid, and gives a white precipitate of sulphate of lead when added to the acetate of that metal.—ED.]

COMPOSITION.—Berzelius[1] says that if 100 parts of carbonate of potash be fused with 58·22 of sulphur, the product is a mixture of three equivalents of tersulphuret of potassium and one equivalent of sulphate of potash; and he adds, that if less than the above proportion of sulphur be employed, a portion of carbonate of potash remains undecomposed. But Winckler[2] has shown that if the carbonate employed be quite pure, and the operation be very carefully conducted, no sulphate is obtained, but hyposulphite and sulphite of potash. He fused together 900 grs. of crystallised basic carbonate of potash (dried at 212° F.) with 518 grs. of washed flowers of sulphur. [These are nearly the proportions of the Dublin College.] The percentage composition of the product was as follows:—

---

[1] *Traité de Chimie*, t. ii. p. 301, Paris, 1831.

[2] *Berlinisches Jahrbuch*, Band xli. S. 321, 1839. A corrected abstract of this paper is contained in the *Pharmaceutisches Central-Blatt für* 1839, S. 547.

Tersulphuret of potassium	53·2905
Hyposulphite of potash	29·4580
Sulphite of potash	6·8613
Sulphate of potash	0·7730
Carbonate of potash	2·8780
Loss	6·7392
Hepar Sulphuris	100·0000

PHYSIOLOGICAL EFFECTS. α. *On Vegetables.*—There can be no doubt that this compound is a powerful poison to plants, although I am not acquainted with any experiments made with it.

β. *On Animals generally.*—From the experiments of Orfila[1] on dogs, sulphuret of potassium appears to be a powerful narcotico-acrid poison. Six drachms and a half, dissolved in water, and introduced into the stomach, caused convulsions and death in seven minutes.

γ. *On Man.*—Its general action has already been referred to. Its effects are analogous to those of hydrosulphuret of ammonia. In *small doses* (as from four to ten grains) it acts as a general stimulant; increasing the frequency of the pulse, augmenting the heat of the body, promoting the different secretions, more especially those of the mucous membranes, and sometimes exciting local irritation, marked by pain, vomiting, and purging. By continued use it acts as a resolvent or alterative, and on this account is employed in certain forms of inflammation. In *large doses*, it is an energetic narcotico-acrid poison. In two instances it proved fatal in fifteen minutes: the symptoms were, acrid taste, slight vomiting, mortal faintness, and convulsions, with an important chemical sign, the tainting the air of the chamber with the odour of hydrosulphuric acid.[2] Its local action is that of a powerful irritant: hence the acrid taste, burning pain, and constriction in the throat, gullet, and stomach, with vomiting and purging. But the nervous system is also affected; as is proved by the faintness, the almost imperceptible pulse, the convulsions, and (in some cases) sopor. These symptoms are analogous to those caused by hydrosulphuric acid; which, in fact, is copiously developed in the stomach. It probably acts chemically on the blood, like sulphuretted hydrogen.

USES.—Internally, it has been administered in very obstinate skin diseases, such as lepra and psoriasis, which have resisted all the ordinary means of cure. It has also been employed as a resolvent in inflammations attended with lymphatic exudation, as croup, and in glandular enlargements. In chronic rheumatism, gout, hooping-cough, and various other diseases, against which it was formerly employed, it is now rarely if ever administered. It ought not to be given as an antidote for metallic poisoning, since it is itself a powerful poison. Externally, it is applied in the form of lotions, baths, or ointment, in chronic skin-diseases, such as eczema, scabies, lepra, and pityriasis.

ADMINISTRATION.—Internally it may be administered in the dose of three or four grains gradually increased. It may be given either in solution, or in the form of a pill made with soap. For external use it is employed in solution in water, either as a bath or wash, or in the form of ointment. ***Lotions*** are sometimes made by dissolving an ounce of the sulphuret in two or three quarts of water. The *ointment* is composed of ʒss. of sulphuret to ℥j. of lard.

---

[1] *Toxicologie Génerale.*

[2] Christison, *Treatise on Poisons.*

ANTIDOTES.—In the event of poisoning by this substance, the antidote is a solution of chloride of soda or of chloride of lime.

1. SOLUTIO POTASSII SULPHURETI. (Washed Sulphur, 1 part; Water of Caustic Potash, 11 parts. Boil during ten minutes, and filter through paper. Let the liquor be kept in well-closed vessels. The sp. gr. of this liquid is 1·117.)—By the mutual reaction of sulphur and potassa, aided by the water and heat, a solution of sulphuret of potassium and hyposulphite of potash is obtained. The colour of this preparation is deep orange. It is sometimes administered in scabies, tinea capitis, and other allied eruptive diseases.—Dose, from ♏x. to fʒj. sufficiently diluted with water.

2. BALNEUM SULPHURATUM; *Sulphurated* or *Sulphurous Bath.*—This is prepared by dissolving ℥iv. of sulphuret of potassium in 30 gallons of water (Rayer). For some purposes a small proportion of sulphuret (as ℥ij.) will be sufficient. It should be prepared in a wooden bathing vessel.—Used in obstinate skin diseases, as lepra and scabies. If an acid be added to this bath, sulphur is precipitated and sulphuretted hydrogen evolved. Care must be taken lest asphyxia be produced by the inhalation of the latter. This bath is an important and valuable agent in the treatment of saturnine poisoning, especially lead colic, saturnine arthralgia, and paralysis from lead. It renders brown or black and destroys the poisonous qualities of any portions of lead contained on the skin, and thereby prevents the further absorption of the poison. The hands, arms, buttocks, and other parts of the body of painters and workmen in white lead manufacturies, are sometimes completely blackened by it:[1] but the blackness is readily removed by a brush. The hair follicles frequently contain plumbeous particles, and are in consequence blackened by the bath. The benefit obtained by the use of the sulphurated bath does not appear to me merely of a preventive nature; but the great relief from already existing symptoms which patients usually obtain by the use of this bath, induces me to believe that the sulphuret becomes absorbed, and acts in the system as a counter-poison, rendering inert the lead which has already been taken up.

3. BALNEUM SULPHURATUM ET GELATINOSUM; *Dupuytren's Gelatino-Sulphurous Bath.* This is prepared by adding one pound of glue (previously dissolved in water) to the sulphuretted bath above described.—It may be used as a substitute for the waters of Barèges; the glue representing the *Baregine,* an organic matter found in these waters. Barèges waters have been celebrated for cleansing foul ulcers, healing old wounds, and curing obstinate skin diseases.

---

[1] A very intelligent pupil of mine (Mr. J. L. Wyatt), who had repeatedly seen the beneficial effects of this bath on patients under my care at the London Hospital, recommended its employment to a medical friend, who then had under treatment a patient supposed to be suffering from the effects of lead. The bath appears to have been most successful; but the practitioner lost his patient in consequence: for, various parts of the body becoming of a deep brown colour, the patient and his friends were firmly persuaded that the doctor had been trying experiments on him, and, consequently, on the following day, the practitioner was informed that his services were no longer required!

44. POTASSÆ SULPHATES.—SULPHATES OF POTASH.

Three compounds of potash with sulphuric acid are known: they are the following:—

1. Monosulphate or the neutral sulphate of potash	KO,SO^3
2. Sesquisulphate of potash	$2KO,3SO^3,HO$
3. Bisulphate of potash	$KO,2SO^3,HO$

It will be perceived from this table that the so-called sesquisulphate contains the sum of the constituents of the two other salts.

1. Potassæ Monosulphas.—Neutral Sulphate of Potash.

Formula KO,SO^3. *Equivalent Weight* 87.

History.—The mode of preparing sulphate of potash was taught by Oswald Croll, in 1643. This salt has been known by various appellations, such as *specificum purgans Paracelsi, arcanum duplicatum, vitriolated kali* (*kali vitriolatum*), *vitriolated tartar* (*tartar vitriolatum*), *nitrum vitriolatum, sal polychrest* (literally signifying *salts of many uses* or *virtues*), *sal de duobus*, &c. It is the *sulphate of potash* (*potassæ sulphas*) of the Pharmacopœias, L. E. D.

Natural History.—Sulphate of potash is found in both kingdoms of nature.

a. In the Inorganised Kingdom.—It has been met with in small quantities in some mineral waters of Saxony and Bohemia, in native alum, in alum-stone, and in a mineral called *polyhalite*, in which Stromeyer found no less than 27·6 per cent. of the sulphate of potash.

β. In the Organised Kingdom.—It has been found in the root of Polygala Senega, Winter's bark, the bulb of garlic, myrrh, opium, &c. The blood and urine of man also contain it.

Preparation.—It is prepared from the residuum of the distillation of nitric acid.

The *London College* has placed this article in the Materia Medica.

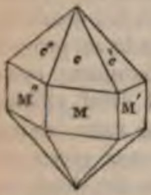
The *Edinburgh* and *Dublin Colleges* order the salt left after the distillation of nitric acid to be dissolved in water, and its excess of acid to be neutralised. The Edinburgh College employs for this purpose white marble (carbonate of lime); while the Dublin College uses carbonate of potash, after neutralising the acid of the residuum by slaked lime. The neutral solution of sulphate of potash is then to be evaporated and crystallised.

Properties.—It usually crystallises in single or double six-sided pyramids. The two pyramids are sometimes united at a common base, or are separated by a short intervening prism (figs. 78 and 79). These forms agree very closely with those belonging to the rhombohedral system. But they have been shown by Dr. Brewster[1] to be composite crystals; being composed of several crystals belonging to the right prismatic system, aggregated so as to simulate the forms of the rhombohedral system. If a plate, cut perpendicular to the axis of the double pyramid, be examined by polarised light, it presents the tessellated structure shown in fig. 81; and each of the six equilateral triangles are found to have two axes of double refraction.

---

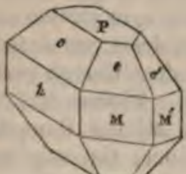
[1] *Edinburgh Philosophical Journal*, vol. i. p. 6, Edinb. 1819.—See also Mr. W. Phillips, *Annals of Philosophy*, N. S. vol. iv. p. 342, Lond. 1822; Levy, *Quarterly Journal of Science*, vol. xv. p. 285, Lond. 1823; and Mr. Brookes, *Ibid*, N. S. vol. vii. p. 20, 1824.

FIG. 78.



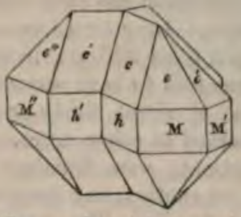
Common bipyramidal crystal with short intervening prism.

FIG. 79.



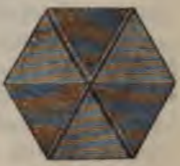
Ditto modified.

FIG. 80.



Compound crystal composed of three so united that their upper edges meet at angles of 120°.

FIG. 81.



Tessellated appearance of a plate of sulphate of potash seen by polarised light.

Crystals of sulphate of potash are hard, inodorous, have a saline bitter taste, and are unchanged by exposure to the air. When heated, they decrepitate. At 60° F. they require sixteen times their weight of water to dissolve them: they are insoluble in alcohol. A solution of them is decomposed by tartaric acid, which forms crystals of bitartrate of potash.

Characteristics.—The characteristics are those of a sulphate, and of a potash salt. To these must be added the crystalline form and relative solubility of the salt.

COMPOSITION.—The crystals contain no water of crystallisation. They are thus composed:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Wenzel.*	*Kirwan.*
Sulphuric acid	1	40	45·977	45·25	45
Potash	1	47	54·023	54·75	55
Sulphate of Potash	1	87	100·000	100·00	100

Slightly soluble in water. That which is thrown down from the solution by bichloride of platina is yellowish,—that by chloride of barium is white, and insoluble in nitric acid. It decrepitates by heat, melts at a red heat, but does not lose weight. 100 grains dissolved in water yield, with chloride of barium and hydrochloric acid, a precipitate of sulphate of baryta, which when dried at a red heat weighs 132 grains.—*Ph. Lond.*

PHYSIOLOGICAL EFFECTS.—Sulphate of potash, when given in moderate doses, usually operates as a mild purgative, without occasioning heat, pain, or any other symptoms of irritation. In doses of from fifteen to thirty grains, I have used it in hundreds of cases, in combination with a third part of powdered rhubarb, without having ever witnessed any injurious effects therefrom. I have also given it, but more rarely, in doses of a drachm, also combined with rhubarb, and without any ill consequences. Many of the patients to whom I have administered it were labouring under mild diarrhœa. In all cases it has appeared to me to act as a mild and safe purgative; and this, until recently, has been the general property ascribed to it by medical writers. In 1839, Wibmer[1] stated that, in doses of from half a scruple to a drachm, it operates as a resolvent, and promotes secretion from the alimentary canal; in doses of from two to six drachms, it acts as a purgative, and likewise as a diuretic, promoting all the secretions and excretions, but having a less cooling and more of a stimulating operation than other neutral salts. In larger doses, he adds, it produces abdominal pain, violent diarrhœa, and even inflammation of the stomach and bowels.

---

[1] *Die Wirkung der Arzneimittel. und Gifte*, 7tes Heft, München, 1839.

More recently,[1] attention has been drawn to its poisonous and, in several instances, fatal effects. In one case two ounces, in another about ten drachms in six doses, and in a third 600 grs. in three doses, are stated to have proved fatal. Death is even said to have occurred after, though perhaps not in consequence of, a dose of about thirty grains. Violent, but not fatal, effects have also been observed in other cases. In all the three fatal cases above referred to, the patients were females: in one, the sulphate was given to produce abortion; in another, as a laxative after parturition; in the third, to stop the secretion of milk. The symptoms resembled cholera: abdominal pain, vomiting, purging, cramps of the extremities, and great exhaustion. In the second case above referred to, death occurred two hours after taking the sixth dose. In one of the three fatal cases the stomach is said to have been highly inflamed, and blood effused on the brain; in the second case the mucous membrane of the stomach and intestines was found pale, except the valvulæ conniventes, which were reddened; in the third case some appearance of inflammation was observed in the stomach.

Various causes have been assigned for these violent and fatal effects. The presence of some deleterious ingredient (as arsenic) in the sulphate of potash taken, and the mechanical irritation of the fine spicula of the powder, have been respectively stated as the cause of the death. But neither of these explanations is admissible. In two of the fatal doses the sulphate was carefully analysed, in one of them by Mr. Brande, in the other by M. Chevallier, but no metallic or other deleterious ingredient was detected. The nature of the effects (different from those produced by the ingestion of pounded glass); the rapidity with which death has occurred after its use; the paleness, in one instance, of the alimentary mucous membrane; and the fact that in the case of some other alkaline salts, death has equally resulted when these agents were taken in the form of solution,—are reasons for rejecting the hypothesis of mechanical action as the cause of the fatal effects produced by sulphate of potash. Although in two of the fatal cases inflammation is mentioned as having been observed in the alimentary canal, yet I cannot admit that this was the cause of death. The symptoms produced were rather those of cholera than of inflammation: the death in one case was too rapid to have been the effect of gastro-intestinal inflammation; the mucous membrane is described in one instance as having been pale; and in none of the cases were the inflammatory appearances such as would, in my opinion, account for the symptoms and death. On the whole, then, I am disposed to believe that the poisonous effects have resulted from the absorption of the salt.

David,[2] Deleurye,[3] and Levret,[4] have ascribed to sulphate of potash the power of repressing the secretion of milk; and their observations have been more recently confirmed by Martin.[5]

---

[1] *Pharmaceutical Journal*, vol. iii. p. 256, 1843.

[2] *Dissertation sur ce qu'il convient faire pour diminuer ou supprimer le Lait des Femmes*, 12mo. Paris, 1763.

[3] *Traité des Accouchemens*, Paris, 1770.

[4] *L'Art des Accouchemens*, 3me éd. Paris, 1766.

[5] *Annalen f. d. gesammte Heilk. in Baden*, 3 Jahrg. H. 2, S. 149.

USES.—Sulphate of potash has been found serviceable as a mild *laxative* in disordered conditions of the alimentary canal, as at the commencement of mild diarrhœa, in dyspepsia, hepatic disorders, and hemorrhoidal affections. It is best given in these cases in combination with rhubarb. Thus from five to ten grains of rhubarb with from fifteen grains to a drachm of this salt will be usually found to act mildly and efficiently. As a *lactifuge* or represser of the milk, it has been much used by some of the French accoucheurs of the last century, as I have already mentioned. Levret also considered it a valuable purgative in the disorders of childbed, especially puerperal fever. It has been esteemed an excellent *aperient* for children. The objections to its employment are its slight solubility, and that when given in large doses to children it is apt to produce vomiting.

It is useful, on account of its hardness and dryness, for triturating and dividing powders, as in the *pulvis ipecacuanhæ compositus*, in which it serves to divide the opium. Its powder, on account of its hardness and solubility, is an excellent dentifrice: the only objection to its use is its taste.

DOSE.—It is given in doses of from fifteen grains to one or two drachms. It is a constituent of the *pulvis salinus compositus*, E.

POTASSÆ SULPHAS CUM SULPHURE, E.; *Sal Polychrestum Glaseri*; *Glaser's Sal Polychrest.* (Nitrate of Potash and Sulphur, equal parts; mix them thoroughly; throw the mixture, in small successive portions, into a red-hot crucible; and when the deflagration is over, and the salt has cooled, reduce it to powder, and preserve it in well-closed bottles.)—The sulphur is oxidised at the expense of the oxygen of the nitric acid, and the resulting greyish-white compound consists principally of sulphate of potash, mixed probably with some sulphite; but the precise nature of the compound has not been carefully determined. Dr. Christison states that it "is much more soluble than sulphate of potash, and it crystallises from a state of solution in rhombic prisms—the primitive form of that salt. Both the substance itself and its solution have a sulphureous odour, but sulphuretted hydrogen is not disengaged on a strong acid being added, nor is sulphuret of lead thrown down by the salts of that metal. The salts of baryta cause a white precipitate, insoluble in nitric acid, so that sulphate of potash is present."[1] Dr. Duncan[2] says "that in its medical effects and exhibition it agrees with the sulphureous mineral waters, which contain a portion of neutral salt." It is used as a purgative in dyspepsia and chronic skin diseases.—Dose, ʒss. to ʒj.

2. Potassæ Sesquisulphas.—Sesquisulphate of Potash.

Formula $2KO,3SO^3,HO$. *Equivalent Weight* 223.

This salt is probably a compound of sulphate of potash (KO,SO^3) and the hydrated bisulphate ($KO,2SO^3,HO$); or of two equivalents of sulphate of potash $2(KO,SO^3)$ and one equivalent of sulphate of water (HO,SO^3). The latter view is that of Professor Graham. This salt is a frequent constituent of the salt remaining after the distillation of the nitric acid, and which was formerly called *sal enixum Paracelsi*. It crystallises in fine, slender, prismatic needles.

---

[1] Dr. Christison's *Dispensatory*, 2d edit. 1848.

[2] *Edinburgh Dispensatory*.

3. Potassæ Bisulphas.—Bisulphate of Potash.

Formula $KO,2SO^3$. *Equivalent Weight* 127.

HISTORY.—The mode of preparing this salt was taught by Lowitz and Link at the latter end of the last century. The salt has had various names; such as *supersulphate of potash, sal enixum, acid vitriolated tartar,* and *sal auri philosophicum.*

PREPARATION.—The Edinburgh and Dublin Colleges give formulæ for the preparation of this salt: it is excluded from the London Pharmacopœia.

The *Edinburgh College* directs it to be prepared by adding sulphuric acid to a solution of the salt which remains after the distillation of pure nitric acid, boiling down and setting aside the solutions that crystals may be formed.

The *Dublin College* prepares it from sulphate of potash in powder, three ounces; pure sulphuric acid, one fluid ounce. Place the acid and salt in a small porcelain capsule, and to this apply a heat capable of liquefying its contents, and which should be continued until acid vapours cease to be given off. The bisulphate, which concretes as it cools, should be reduced to a fine powder and preserved in a well-stoppered bottle.

The salt which remains in the retort after the distillation of nitric acid of the London and Edinburgh Pharmacopœias, is a bisulphate of potash. If it be dissolved in water, and the solution allowed to crystallise, neutral sulphate is first deposited; and, by further evaporation, some anhydrous bisulphate is obtained. But by employing a considerable excess of sulphuric acid (two equivalents), the formation of the neutral sulphate is prevented, and bisulphate only is procured. The crystals which are first formed are acicular and anhydrous; but this anhydrous salt subsequently liquefies, and forms rhomboidal crystals of the hydrous bisulphate. This change occurs the more quickly as the excess of acid is greater.[1]

PROPERTIES.—There are two bisulphates of potash—the anhydrous and the hydrous.

a. Anhydrous bisulphate of potash.—This appears in acute prisms or acicular crystals, whose sp. gr. is 2·277, and which fuse at 410° F. It may be dissolved and crystallised again from a quantity of hot water not more than sufficient to dissolve it: a larger quantity of water decomposes it. Left in their mother-liquor, the crystals disappear, and crystals of the hydrated bisulphate are formed. The anhydrous bisulphate is thus composed:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Jacquelain.*
Potash	1	47	37	37·05
Sulphuric acid	2	80	63	62·95
Anhydrous Bisulphate of Potash	1	127	100	100·00

β. Hydrous bisulphate of potash.—There are probably two hydrous bisulphates—one with a single equivalent of water, and another with two equivalents.

Jacquelain[2] states that the hydrous bisulphate crystallises partly in rhombohedral prisms, whose sp. gr. is 2·163, and which fuse at 386°·6 Fahr.;

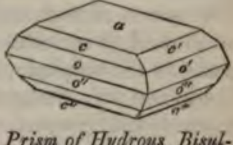
---

[1] [In this mode of producing the salt, care must be taken to avoid the use of the double salt of sulphate of potash and lime, found by Mr. Phillips as an incrustation on the boiler in which the impure sulphate of potash solution is concentrated, and which is sometimes mixed with the sulphate of potash sold (*Pharmaceutical Journal*, 1851–2, p. 36).—ED.]

[2] *Ann. de Chim. et de Phys.* t. lxx. p. 311, 1839.

and partly in silky filaments formed by the union of the rhombohedral crystals. According to Mitscherlich,[1] the large crystals obtained out of the watery solution are isomorphous with those of sulphur obtained by slow cooling (see fig. 56); while those procured by fusion agree with the crystals of feldspar. Mr. R. Phillips[2] describes the primary form of the crystal of the hydrous bisulphate as a right rhombic prism, having but one cleavage—namely, parallel to plane *a*,—and being often much flatter than the sketch (fig. 82).

FIG. 82.



Prism of Hydrous Bisulphate of Potash.

Hydrous bisulphate of potash has a very acid taste, reacts strongly as an acid on vegetable colours, and decomposes the carbonates with effervescence. Below 386°·6 F. it is a white crystalline mass. It is very soluble in water, but is partially decomposed by that liquid, and the solution deposits neutral sulphate of potash. By a red heat it is decomposed, and evolves water and sulphuric acid: it is then converted into the neutral sulphate.

Characteristics.—The presence of sulphuric acid may be recognised by the chloride of barium. When subjected for some time to a red heat, bisulphate of potash loses its water and half of its acid. The residue is the neutral sulphate, the potash of which may be detected by the characters already mentioned for this substance.

The bisulphate is distinguished from the neutral sulphate by the difference of crystalline form, by its greater fusibility, greater solubility, its acid taste, and its action on litmus and the alkaline carbonates. The following, according to Jacquelain, are the differences between the sulphates of potash:—

Names.	*Formulæ.*	*Crystalline shape.*	*Sp. gr.*	*Fusibility.*	
1. Neutral sulphate of potash...............	KO,SO^3	Six-sided prisms	2·4	Cherry-red heat	
2. Anhydrous bisulphate of potash............	$KO,2SO^3$	Prisms	2·277	410°·6F.	Both decomposed by water and alcohol.
3. Hydrous bisulphate of potash............	KO,SO^3+HO,SO^3	Rhombohedral prisms	2·163	386° F.	

COMPOSITION.—According to Jacquelain, Graham, and Mitscherlich, the composition of hydrous bisulphate of potash is as follows:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	JACQUELAIN.	
				Rhomb. Prisms.	*Silky Filaments.*
Potash	1	47	34·559	34·55	34·56
Sulphuric acid	2	80	58·323	58·48	58·69
Water	1	9	6·618	6·97	6·75
Hydrous Bisulphate of Potash	1	136	100·000	100·00	100·00

But Geiger, R. Phillips, and Dr. T. Thomson, state that it contains two atoms of water:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	GEIGER.	
				Rhomb. Prisms.	*4 & 6-sided Needles.*
Potash	1	47	32·414	32·53	33·83
Sulphuric acid	2	80	55·172	54·77	55·43
Water	2	18	12·414	12·70	10·74
Hydrous Bisulphate Potash	1	145	100·000	100·00	100·00

---

[1] Quoted by L. Gmelin, *Hanb. d. Chemie*, t. ii. p. 40, 4te Aufl.

[2] *Translation of the Pharmacopœia.*

It is probable, therefore, that there are two hydrous bisulphates.

Physiological Effects and Uses.—It is rarely used as a medicine. It possesses the combined properties of sulphuric acid and sulphate of potash. The excess of acid renders its local operation that of an astringent. When swallowed, it operates as a mild purgative, and may be employed in the same cases as the sulphate, over which it has the advantage of greater solubility. Conjoined with rhubarb, it covers the bitter taste of the latter without injuring its medicinal properties. Dr. Barker[1] says it may be used to form a cheap effervescing purgative salt as follows:—73 grains of bisulphate of potash and 72 grains of crystallised carbonate of soda, to be separately dissolved in two ounces of water, and taken in a state of effervescence. In the arts, it is used as a substitute for dilute sulphuric acid, for cleansing iron and other metallic works.

Administration.—The dose of it is from gr. x. to ʒij. properly diluted.

45. Potassii Chloridum.—Chloride of Potassium.

Formula KCl. *Equivalent Weight* 74·5.

Muriate of potash; Febrifuge or digestive salt of Sylvius (*sal digestivum seu febrifugum Sylvii*); *Regenerated sea salt; Diuretic sal ammoniac* (*sal ammoniacum diureticum*); *Potassane.*—Employed as a medicine by Sylvius de la Boe in the 17th century. Minute cubical crystals of it have been found in the lava of Vesuvius. It exists, though in minute quantities, in sea water (see *ante*, p. 302), in several mineral waters, in rock salt, and in vegetable and animal fluids (*e. g.* in the juice of flesh and in animal milk). It is obtained as a secondary product in various chemical processes; as in the manufacture of tartaric acid, iodine, chlorate of potash, soap, glass, &c., and in the refining of saltpetre. It occurs in prismatic, cubical, or octahedral crystals. In taste it resembles common salt. While dissolving in water, it produces a much greater degree of cold than chloride of sodium. In its medicinal properties it resembles common salt. It was formerly used in medicine as a diaphoretic, resolvent, and febrifuge; but of late years it has almost entirely fallen into disuse. If, however, Dr. Garrod's hypothesis of the cause of scurvy be correct, it might be advantageously mixed with common salt, and used at table as an antiscorbutic. The dose of it is ℈j. to ʒss. or more. Its principal consumption, at the present time, is in the manufacture of alum. It is also occasionally employed as a test for tartaric acid.

46. Potassæ Hypochloris.—Hypochlorite of Potash.

Formula KO,ClO. *Equivalent Weight* 90·5.

A watery solution of hypochlorite of potash and of chloride of potassium constitutes the *Eau de Javelle*, or the *solution of chloride of potash* (*liquor potassæ chloridi*), or *chlorinated potash water* (*aqua potassæ chlorinatæ*). It is prepared either by passing chlorine gas into carbonate of potash, so as not quite to saturate the alkali; or by decomposing ℥ij. of chloride of lime contained in Oiss. of water by ℥iv. of carbonate of potash dissolved in Oss. of water, and filtering the mixture. The liquid owes its bleaching and disinfecting properties to the hypochlorite of potash. Its medicinal properties and uses are similar to those of chloride of soda (see *Sodæ Hypochloris*). It is eliminated by the kidneys. Some cases of poisoning with it have occurred.[2] It appeared to act as a chemical irritant. Albuminous liquids (white of egg and water, milk, flour and water) are the best antidotes.

---

[1] *Observations on the Dublin Pharmacopœia*, p. 138, Dublin, 1830.

[2] A. S. Taylor, *On Poisons*, p. 284.

47. POTASSÆ CHLORAS.—CHLORATE OF POTASH.

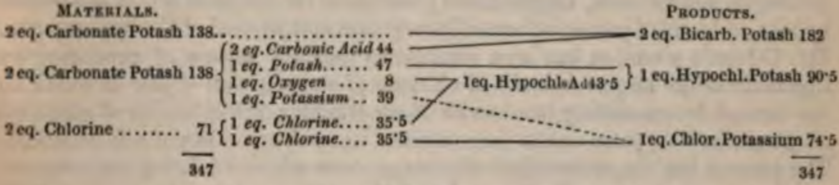
Formula KO,ClO^5. *Equivalent Weight* 122·5.

HISTORY.—Chlorate of potash, formerly called *oxymuriate* or *hyperoxymuriate of potash,* was first obtained, in 1786, by Mr. Higgins,[1] who mistook it for nitrate of potash. In 1786 it was distinguished by Berthollet.

PREPARATION.—There are several methods of procuring it :—

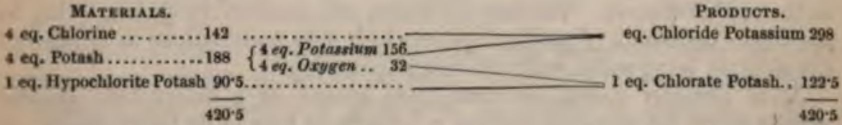
1. By the old method it is prepared by passing chlorine gas slowly through a cold solution of carbonate of potash placed in a Woulfe's bottle. The liquid is allowed to stand for twenty-four hours in a cool place, and is then found to have deposited crystals of chlorate of potash. These are to be drained, washed with cold water, dissolved in hot water, and re-crystallised.

When chlorine gas comes in contact with a solution of carbonate of potash, three salts are formed:—chloride of potassium, hypochlorite of potash, and bicarbonate of potash. $4(KO,CO^2) + 2Cl = 2(KO,2CO^2) + KO,ClO + KCl$.



In proportion as the quantity of chlorine increases, the bicarbonate becomes decomposed; carbonic acid is evolved, and a further quantity of hypochlorite of potash and chloride of potassium is produced. By the reaction of the carbonic acid on some hypochlorite of potash, a portion of hypochlorous acid is set free, which gives the liquor a yellow tinge.[2]

When the solution is strongly charged with hypochlorite, the action of the chlorine on the potash is somewhat changed: it abstracts the potassium from the potash, and thereby forms chloride of potassium; while the oxygen thus set free combines with some hypochlorite of potash, and thereby converts it into the chlorate, the greater part of which crystallises. $4Cl + 4KO + KOClO = 4(KCl) + KO,ClO^5$.


MATERIALS.
PRODUCTS.
4 eq. Chlorine 142
4 eq. Potash 188
4 eq. Potassium 156
4 eq. Oxygen .. 32
1 eq. Hypochlorite Potash 90·5
420·5
eq. Chloride Potassium 298
1 eq. Chlorate Potash.. 122·5
420·5

The residual liquor contains a little chlorate, some free hypochlorous acid, and a considerable quantity of hypochlorite of potash and chloride of potassium.

2. The preceding process is attended with some practical difficulties, to obviate which Professor Graham[3] recommends that carbonate of potash be mixed intimately with an equivalent quantity of dry hydrate of lime, and the mixture exposed to chlorine gas: the products are carbonate of lime, chlorate

---

[1] *Experiments and Observations relative to Acetous Acid, &c.* Lond. 1786.

[2] Delmar, in *Lond. Edinb. and Dubl. Phil. Mag.* for June 1841, p. 422.

[3] *Proceedings of the Chemical Society,* No. 1.

of potash, and c
$6(CaO,CO^2)+5(K$
potash and chloric
and the chlorate o
3. According t
chloride of lime in
boiling to dryness.
filtered, if necess
deposited. 3(CaC
of lime of commer
dissolve a known
it, by which means
compound.

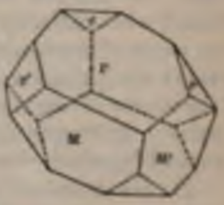
[Mr. F. C. Calv
ordinary temperatu
lime in suspension,
potassium and calc
by heat, chlorate of
Mr. Calvert's atten
this method the lar
has arrived by exa
of caustic potash, m
The process has the
mical. A solution
or containing 10·2
fluid operated upor
potassium. To thi
slaked. The whole
passed through, the
intensity of the ch
when the liquid ref
rated nearly to dryn
filtered. After was
liquors were evapor
obtained in this exp
in the mother-liquor
the rather large bull
the chlorate being s

It is certainly r
gravity where the ch
where, in other wor
while in solutions of
produced, with a c
chemical reaction is
of the same fact in m
Thus, in a liquid of s
potassium in combin
entirely from the ac

calcium applies itself to the chlorine, to transform the latter into chloric acid, which neutralises the potash only. This is probably the only example in chemistry, where, in the presence of two bases, the chlorine applies itself almost entirely to one of the metals, at the same time that a portion being oxidised forms an acid which neutralises the second base.—ED.]

PROPERTIES.—Chlorate of potash crystallises in nearly rhomboidal plates belonging to the oblique prismatic system. Its taste is cool, and somewhat similar to nitre. When rubbed in the dark, it becomes luminous. It is but slightly soluble in cold water, and may be thus separated from the chloride. 100 parts of water at 32° F. dissolve 3·5 parts of chlorate; at 59° F. 6 parts; at 120° F. 19 parts. Chlorate of potash is a colourless, inodorous, crystalline salt which occurs in rhomboidal nacreous tables; its taste resembles that of nitrate of potash. Its primary form is an oblique rhombic prism. The cleavage parallel to the planes M and M′ is easy, and the cleavage planes brilliant; but the crystals are usually too thin to obtain a cleavage plane parallel to P.

FIG. 83.



Characteristics.—This salt is known to be a chlorate by the following characters:—When heated, it fuses at 400°, and when the heat is raised to about 600° it gives out oxygen, and is converted into chloride of potassium (see *ante*, p. 273); when thrown on a red-hot coal, it deflagrates—a property, however, common to several other salts. Sulphuric acid gives it an orange-red colour, evolves chlorous acid (peroxide of chlorine), known by its greenish-yellow colour, and great explosive power when heated. Rubbed with sulphur or phosphorus, it explodes violently. Mixed with hydrochloric acid, and then with water, it evolves chlorine, dissolves gold, and forms a bleaching liquid. The base of the salt is known to be potash by the tests for this substance already mentioned.

COMPOSITION.—It is an anhydrous salt.

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Berzelius.*
Potash	1	47	38·37	38·4917
Chloric acid	1	75·5	61·63	61·5083
Chlorate of Potash	1	122·5	100·00	100·0000

IMPURITY.—Chloride of potassium is the usual impurity. This may be detected by a solution of nitrate of silver producing a white precipitate (*chloride of silver*), insoluble in nitric acid, but soluble in ammonia. Pure chlorate of potash undergoes no obvious change on the addition of nitrate of silver to its solution.

In the London Pharmacopœia the following tests are given to determine the purity of the salt:—

Soluble in water. The solution precipitates nothing when nitrate of silver is added to it. By heat it liquefies, and at a red heat one hundred grains yield nearly thirty-nine grains of oxygen gas. A very few minims of sulphuric acid dropped on the crystals, the salt first becomes yellow, afterwards red, and exhales yellow vapours of peroxide of chlorine. Rubbed with sulphur, it detonates. If any chloride of potassium be present, then nitrate of silver, instead of yielding no precipitate, gives a white one of chloride of silver, insoluble in nitric acid. When it loses oxygen by heat, the residual salt is

chloride of potassiu
rubbed with phosp

Physiologica
experiments, Dr.
potash, dissolved
dog: no ill effe
urine was found
the tracheal vein
the animal was s
gas: the brachi
could with diffic
in water of the t
vein: the pulsat
the course of ei
veins. In twent
copiously, which
β. On Man.-
It becomes absor
appears to act as
writers it is denon
recognised it in
it does not appea
system. This fa
who fancied tha
adapted for patie
to depend on a d
like those of the
system; but I a
chateau[3] says tha
but the observat
these effects fro
gives a beautiful
much faster than
Uses.—Chlor
and Dublin Coll
preparations. It
the system, wher
that view is was
scorbutus. Dr.
quently applied i
for mercurials, w
which they comm

---

[1] Phillips's *Transla*
[2] *Lancet* for 1831–
[3] Mérat and De Le
[4] *On the Blood*, p.
[5] Duncan's *Annals*
[6] *Med. Hist. and R*
[7] See the Reports
Mellitus, 2d edit. pp.

debility, on account of its supposed tonic effects, but failed in the hands of Dr. Ferriar.[1] In a case of dropsy under the care of the latter gentleman, it operated successfully as a diuretic. More recently, it has been used by Dr. Stevens[2] and others as a remedy for fever, cholera, and other malignant diseases, which, he supposes, depend on a deficiency of the saline matters in the blood; but as it has been usually employed in conjunction with common salt and carbonate of soda, it is impossible to declare what share the chlorate had in producing the beneficial effects said to have been obtained by what is called the *saline* treatment of these diseases. Köhler[3] tried it in phthisis, without experiencing benefit from it.

It appears, then, that most of the uses of this salt have been founded on certain views of chemical pathology, some of which are now considered untenable. It is very desirable, therefore, that some person, unbiassed by theoretical opinions, would carefully investigate its effects and uses, which I am inclined to think have been much overrated. In a therapeutical point of view it may be regarded as analogous to nitrate of potash; though by some it is considered to hold an intermediate position between nitre and sal ammoniac.

It is sometimes employed in scarlatina, cynanche maligna, stomatitis, and cancrum oris. Frequently it is administered in conjunction with hydrochloric acid as a source of chlorine (see *Mistura et Gargarisma Chlorinii*).

Cotton wool impregnated with a concentrated solution has been employed as a moxa.

ADMINISTRATION.—The usual dose of it is from ten or fifteen grains to half a drachm. Dr. Wittman, in one case, gave 160 grains daily, with a little hydrochloric acid immediately after it, to decompose it. The effects were hot skin; headache; quick, full, and hard pulse; white tongue; and augmentation of urine.

48. POTASSII IODIDUM.—IODIDE OF POTASSIUM.

Formula KI. *Equivalent Weight* 165.

HISTORY.—This salt, called also *ioduret of potassium*, and more commonly *hydriodate of potash* (*potassæ hydriodas*), was first employed in medicine by Dr. Coindet.

NATURAL HISTORY.—Iodine is contained in sea-water as well as in sea-weeds, in sponges, in oysters, and other marine mollusca, but it is probable that the iodine is in combination with sodium or magnesium, and not with potassium. [It is also found in a state of saline combination in certain mineral springs in England and on the continent.—ED.]

PREPARATION.—Two of the British Colleges give directions for the preparation of this salt.

The *Edinburgh College* employs of Iodine (dry), ℥v.; Fine Iron-Wire, ℥iij.; Water, Oiv.; Carbonate of Potash (dry), ℥ij. and ʒvj.

The process of the Dublin College is very similar, and one description may suffice for the two. The *Dublin College* orders:—Of pure Iodine, reduced to powder, ℥ivss.; Filings or thin Turnings of Wrought Iron, separated from impurities by a magnet, ℥ij.;

---

[1] *Op. cit.*

[2] *Op. supra cit.* p. 296.

[3] *Lancet* for 1836-7, vol. i. p. 33.

Pure Carbonate of
gently ℥v. of the w
boil until the solu
filter with ℥v. of w
solve, by digestion
dissolved in a quar
solution of iron an
little more carbonat
now, washing the p
evaporated the liqu
crystals may form.
furnished with a pe
rated will, by furthe

The following
iodine combines
iodide of iron is
one equivalent of
$FeI + KO,CO^2 =$

Materials.

1 eq. Iodide of Iron 154

1 eq. Carbonate of
Potash 69

223

Prepared by this
carbonate of pota
[No process f
Pharmacopœia.
Another mode
It consists in add
liquid will dissolv
pass hydrosulphu
a gentle heat, to ex
and exactly neutr
In this process, w
formed—iodide of
The iodate is dec
forms water, by
precipitated, and i
$KI + 6HO + 6S.$
mixture of iodate
a red heat in a
equivalents of oxy
$KI + 6O.$ A littl

Mr. Scanlan infor
before they are subj
carbon.

---

[1] Messrs. Smith pr
heating to redness crys
free from colour, they f

Iodide of potassium may be obtained by various other processes. Mohr[1] prepares it by converting sulphuret of barium, by means of iodine, into iodide of barium, and decomposing this by sulphate of potash. Another method is to boil lime with iodine, by which iodide of calcium and iodate of lime are formed, and to precipitate the lime by carbonate of potash. The iodate of potash, mixed with the iodide, may be decomposed by heat, or by protoxide of iron.[2]

PROPERTIES.—This salt occurs in white, somewhat shining, transparent, or semi-opaque cubes, or octohedrons, belonging to the regular system. Its taste is acrid saline, somewhat similar to common salt. It fuses at a red heat, and at a very high temperature volatilizes unchanged. It decrepitates when heated. Both water and alcohol readily dissolve it: it requires only two-thirds of its weight of water to dissolve it at 60° F. Its aqueous solution dissolves iodine, forming a liquid called *ioduretted iodide of potassium* (*biniodide of potassium*).

Characteristics.—A solution of this salt is known to contain an *iodide* by the following tests:—

α. A solution of perchloride of mercury occasions a vermilion-red precipitate (*periodide of mercury*) soluble in excess of iodide of potassium.
β. A solution of acetate of lead produces a yellow precipitate (*iodide of lead*).
γ. A solution of nitrate of silver causes a pale yellow precipitate (*iodide of silver*).
δ. Protonitrate of mercury or calomel occasions a greyish or a greenish yellow precipitate (*protiodide of mercury*).
ε. On the addition of a cold solution of starch and a few drops of nitric acid (or solution of chlorine, or, still better, according to Devergie, a mixture of chlorine and nitric acid), a blue compound (*iodide of starch*) is formed, which is decolorised at a boiling temperature, or by caustic alkali. [A modification of this test consists in passing into the mixture of iodide and starch, nitrous acid vapour produced in a bent tube by the action of nitric acid on copper. It should be remembered that an excess of chlorine or of strong nitric acid destroys the blue compound.—ED.]
ζ. Bichloride of platinum renders the solution brownish red (*biniodide of platinum*.)
θ. When oil of vitriol and heat are applied to iodide of potassium a violet-coloured vapour is evolved.

That the base of the salt is *potassium* may be very readily proved by the following characters:—

α. Perchloric acid occasions a white precipitate (*perchlorate of potash*), while the supernatant liquor becomes yellowish brown, from a little free iodine.
β. Excess of a strong solution of tartaric acid produces a white crystalline precipitate (*bitartrate of potash*).
γ. Carbazotic acid forms yellow needle-like crystals (*carbazotate of potash*).
δ. If a fine platina wire be dipped in a solution of the iodide, and the wetted end dried and applied to the exterior or blue cone of the flame of a candle, this cone assumes a pale violet tint, indicative of the presence of potassium.

COMPOSITION.—This salt consists, as its name indicates, of iodine and potassium.

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Gay Lussac.*
Iodine	1	126	76·36	76·2
Potassium	1	39	23·64	23·8
Iodide of Potassium	1	165	100·00	100·0

The crystals contain interstitial water, but no water of crystallization.

---

[1] *Pharmaceutical Journal*, vol. v. p. 188.
[2] Mr. R. Phillips, Jun. *Pharmaceutical Journal*, vol. iv. p. 59.

ADULTERATIO
carbonate of po
cent. of the latte
cent. of carbonat
The impure salt
form; by addin
of lime) is obtai
pure; by its str
of iodine, where
spirit, which diss
of the chlorides
potassium. To
the carbonates,
ammonia, which
the addition of r
down, while the
may be detected
(*sulphate of ba*
contaminated wi
to a solution of
copper and two
iodine is thrown
bromine, as well
The bromine is t
of chlorine (or h
phuric ether: th
ether, to which i

In the first ed
of iodide of pota
an odour of iod
and potash only,
Mr. Scanlan[4] ha
of potassium is
has been already
by adding to a s
the iodide be pu
quickly yellow b
which is thus ge
quantity of free
reaction of the
iodine are genera
tartaric acid caus

Iodide of pot
derived from the
of it, in octohedr

---

[1] For some remark
ceutical Journal, vol.
[2] *Med. and Phys.*
[3] *Dispensatory*, 18
[4] *Lancet*, Aug. 29,

presume, from the metallic vessels in which the salt had been prepared. It is sometimes contaminated with a *sulphuretted organic matter* (xanthate of potash?) formed by the employment of spirit of wine and sulphuretted hydrogen, or a metallic sulphuret, in the preparation of the iodide. Iodide of potassium thus contaminated has an unpleasant assafœtida-like odour: it evolves sulphurous acid and becomes greyish-brown when heated; and the residue, treated with water, yields a solution which contains sulphate of potash, as well as iodide of potassium, while a sulphuretted coal remains behind (L. Gmelin).

The following are the characters of pure iodide of potassium according to the *London College*:—

> The crystals are soluble in six or eight parts of rectified spirit, very soluble in water. This aqueous solution does not at all, or only in a very slight manner, change the colour of turmeric to brown; it does not alter the colour of litmus; nitric acid and starch being added together, it becomes blue; tartaric acid and starch being added it is not coloured. What is precipitated from the aqueous solution by acetate of lead is yellow, and is soluble in boiling water; but nothing is precipitated on the addition of lime water or chloride of barium. Moreover, if that which is precipitated by nitrate of silver be digested in strong solution of ammonia, and nitric acid then added to the filtered liquor, nothing is precipitated from it. From one hundred grains dissolved in water, by the addition of nitrate of silver one hundred and forty-one grains of iodide of silver are precipitated. *Ph. Lond.*
>
> [If the colour of turmeric be changed to brown by iodide of potassium, the presence of potash or its carbonate is indicated; if litmus be altered an acid is to be suspected. If lime-water give a precipitate, this may be carbonate of lime, denoting the presence of carbonate of potash; and if chloride of barium render the solution turbid, it may be owing to the formation of carbonate or sulphate of barytes, or of both of them; the former dissolves in hydrochloric acid with effervescence, while the latter is insoluble in it. If the precipitated iodide of silver contain any chloride, it will be dissolved by the ammonia, and again precipitated on supersaturation with nitric acid; but iodide of silver is insoluble in ammonia. If more than one hundred and forty-one grains of precipitate are yielded by one hundred of iodide with the nitrate of silver, this is probably owing to the presence of some chloride of potassium. The iodide of potassium should lose no weight by being heated to 212°, and very little if heated much above that temperature, unless in an open vessel.[1]—ED.]

The *Edinburgh College* gives the following characters of the pure iodide:—

> Its solution is not affected, or is merely rendered hazy, by solution of nitrate of baryta. A solution of five grains, in a fluidounce of distilled water, precipitated by an excess of solution of nitrate of silver, and then agitated in a bottle with a little aqua ammoniæ, yields quickly, by subsidence, a clear supernatant liquor, which is not altered by an excess of nitric acid, or is rendered merely hazy.

The nitrate of baryta forms a white precipitate with either an alkaline carbonate or sulphate. The nitrate of silver is used to detect any chloride.

PHYSIOLOGICAL EFFECTS. *α. On Vegetables.*—The effects of this salt on vegetables have not been ascertained.

β. On Animals generally.—The experiments of Devergie[2] on dogs, as well as those of Dr. Cogswell[3] on rabbits, have shown that, to these animals, iodide of potassium is a powerful poison. It operates as a local irritant, and thereby inflames the tissues with which it is placed in contact. Four grains injected into the jugular vein of a dog caused convulsions and death within a

---

[1] Phillips's *Translation of the London Pharmacopœia*, 1851, p. 32.

[2] *Médecine Légale*, t. ii. p. 538.

[3] *Experimental Essay on Iodine*, Edinb. 1837.

minute. Two
and great depres
third day : after
were observed.[1]
the skin of the b
examination iodi
spinal cord; the
from their appen
γ. *On Man.*
iodide of potassi
The *local act*
reacts chemicall
When taken int
vomiting, pain,
the form of oint
energetic in its a
doses, and contin
to produce disord
baths at 100° F.
temporary itchin
ten scruples of
separated, or con
itching), and su
action of iodide
might be expect
solution of this
most abundant c
Iodide of pota
the different secr
detected.[4] More
urine several day
add first starch
solution of chlor
iodide be present
liquor amnii of a
had taken the io
whom he had adn
The *remote*
analogous to thos
Relaxation of th
observed.[8] Dr.

---

[1] Devergie, *op. cit.*
[2] Cogswell, *op. cit.*
[3] *Essays on the Eff*
[4] Buchanan, *Lond.*
latter authority failed t
[5] Christison, *Treatis*
[6] *Comptes Rendus*, 1
[7] Heller's *Archiv.* 1
[8] Dr. Clendinning,
vol. ii. p. 8.

Atrophy of the mammæ is a very rare effect of it, but a case is mentioned by Mr. Nesse Hill.[1] Wasting of the testicle, also, is said to have resulted from its use.[2] Headache, watchfulness, and other symptoms indicative of the action of this salt on the nervous system, have been noticed by Dr. Clendinning and Dr. Wallace. Increased secretion from, and pain of, the mucous membrane lining the nasal passages have been observed. I have repeatedly remarked, that the pocket-handkerchiefs used by patients who are taking this salt acquire a distinct odour of iodine.

Great discrepancy exists in the statements of authors as to the effects of given doses of iodide of potassium. "The average dose of this medicine," says Dr. Williams,[3] "is eight grains; carried beyond that quantity it purges; and even limited to that quantity, it requires some management to obviate nausea." In two cases mentioned by Dr. Wallace,[4] a drachm of this salt taken in divided doses caused vomiting, colicky pains, slight diarrhœa, frequency of pulse, and exhaustion. Mr. Erichsen has reported a case of extreme irritation of the nasal, conjunctival, and bronchial mucous membrane produced by five grains of the iodide; and Dr. Laurie has known seven and a half grains, given in three doses, cause serious symptoms; and in two cases he thinks death was the consequence of small doses presented medicinally.[5] These statements, then, show that this salt possesses very active properties; they are confirmed by the experience of many practitioners as well as by the results obtained from experiments on animals. But we have, in opposition to the above, the evidence of Dr. Elliotson,[6] of Dr. Buchanan,[7] and, more recently, Payen and Ricord. The first tells us that six drachms may be given daily (in doses of two drachms) for many weeks without inconvenience; and the second states that half an ounce may be given at a dose without producing pain of the stomach or bowels, purging, or any hurtful effect. Furthermore, both physicians vouch for the purity of the salt employed. Payen gave sixty grains daily, and Ricord one hundred and thirty-five, without any serious effects.[8] It is difficult to explain such discrepancies. But I cannot help thinking that peculiarities of constitution and morbid conditions of system (especially affections of the stomach) are principally concerned in modifying (either increasing or diminishing) the tolerance of this salt. I do not think that the different effects observed can be wholly ascribed to alterations in the quality or adulterations of the medicine employed, although I have published a case[9] showing that the adulterated is much less active than the pure salt. May not, in some cases, the different effects have depended on the degree of concentration of the solution of the salt? Weak solutions would probably become absorbed; stronger ones fail to do so.

USES.—Having so fully detailed (see *ante*, p. 404 *et seq.*) the uses of iodine, it is unnecessary to notice at any length those of iodide of potassium, since they are for the most part identical. Thus it has been employed in

---

[1] *Edinb. Med. and Surg. Journ.* vol. xxv. 1826, p. 282.
[2] *Lancet*, Oct. 16, 1841.
[3] *Lond. Med. Gaz.* vol. xiv. p. 42. See also *Lancet*, Oct. 16, 1841.
[4] *Lancet*, for 1835-6, vol. ii. p. 9.
[5] *Lond. Med. Gaz.* vol. xxvi. p. 588.
[6] *Lancet*, vol. i. 1831-2, p. 728.
[7] *Lond. Med. Gaz.* vol. xviii. p. 519.
[8] Dr. A. S. Taylor, *On Poisons*, p. 827.
[9] *Lond. Med. Gaz.* vol. xvii. p. 839.

bronchocele, sc
enlargement of
articular rheum
brought on by
with it uniform
effects are felt;
majority of cas
also borne testi
eruptions Dr.
some valuable
diseases. In ch
of the textures
an ingredient fo
that it was usef

[Iodide of po
and subsequent
in two-grain dos
together. In o
effecting a perm
to be serviceab
effects in the tre
applied (rest bei
the swelling to s

One of the m
lead poisoning.
of chronic poison
of Sciences, Pari
supposed that th
elimination from
it appears that a
from the admi
duced no good
gradually increas

According to
compounds form
with lead and m
are excreted by t
detected.[10] Dr.
was detected in
potassium.[11]

---

[1] *Lond. Med. Gaz.*
[2] *Ibid.* vol. xv. p. 83
[3] *Lancet*, for 1835–
[4] Dr. Clendinning,
vol. xxi. p. 361.
[5] *Essays*, p. 75.
[6] *Bulletin Thérapeut*
[7] *Ibid.* t. xxxviii. p.
[8] *Med. Times*, vol. x
[9] *Med. Gaz.* vol. xliii.
[10] *L'Union Med.* Jan.
[11] *Brit. and For. Med.*

Dr. Budd, who has given a full translation of the memoir by M. Melsens,[1] states that he has observed instances in which mercurial salivation has come on during the use of iodide of potassium; the mercury which had been previously fixed in the body having been liberated under the solvent influence of the iodide of potassium; the mercury thus set free having been the cause of the ptyalism.

The excessive use of iodide of potassium has been frequently attended with serious effects. Dr. Flagg, of Charleston, U.S. has observed the following pathological effects of the long-continued use of the compound: tumefaction of the gums, salivation, epigastric pain, diarrhœa, diuresis, coryza, eczema, purpura, conjunctivitis, augmented secretion of the genital mucous membranes, and cerebral excitement.[2]—ED.]

ADMINISTRATION.—Iodide of potassium may be employed alone or in conjunction with iodine, forming what is called ioduretted iodide of potassium. *Internally* it has been given alone in doses varying from three grains to half an ounce (see *ante*, p. 519). To be beneficial, some think it should be given in small, others in large doses. Not having had any experience of the effects of the enormous doses before referred to, I can offer no opinion thereon. The usual dose which I am in the habit of giving to adults is five grains. It may be administered dissolved in simple or medicated water, or in some bitter infusion. It is frequently administered in combination with iodine.

ANTIDOTES.—No chemical antidote is known. In a case of poisoning, therefore, the first object will be to evacuate the contents of the stomach, exhibit demulcent and emollient drinks, combat the inflammation by the usual antiphlogistic measures, and appease the pain by opiates.

1. UNGUENTUM POTASSII IODIDI, *L. D., Ointment of Iodide of Potassium.*—Iodide of Potassium, ʒij. (ʒj. *D.*); Distilled Water, boiling, ʒij. (cold, ʒss. *D.*); Lard, ℥ij.; (Ointment of White Wax, ʒvij. *D.*) Dissolve the iodide in the water, then mix with the lard, *L.* Triturate the iodide of potassium with the water, then add the ointment and rub them well together, *D.*—In the preparation of this ointment two advantages are gained by dissolving the iodide in water previous to its admixture with the lard:—it obviates the inconvenience of the small particles of iodide irritating the skin, and it facilitates the absorption of the salt. The weight of water required is somewhat less than that of the iodide employed. By keeping, this ointment is apt to acquire a yellowish colour, obviously from a little iodine being set free. In some cases this may depend on the iodine being contaminated with a little iodate of potash. It usually, however, arises from the action of the fatty acid (contained in the rancid fat) on the potassium of the iodide. If spermaceti ointment be substituted for lard, as in the Dublin preparation, the change is more speedy. Mr. Bell[3] thinks this arises from the wax (used in preparing the ointment) having been bleached with chlorine, of which a trace is retained by it; and thus a minute portion of iodine is liberated. [A. W. Krieger states that a few drops of liq. potassæ added to this ointment will preserve from four to eight ounces for months from the yellow discoloration, or restore the white in the ointment that has become yellow.[1]—Ed.] When pure and fresh made, this ointment does not stain the skin like the compound ointment of iodine. Its strength should be twice or thrice that of the Dublin preparation. Messrs. Smith,[2] of Edinburgh, have proposed an ointment containing a drachm of iodide and a drachm of water to an ounce of lard.

---

[1] *Brit. and For. Med.-Chir. Rev.* Jan. 1853.
[2] *Med. Times*, vol. xx. p. 157, quoted from *Charleston Med. Journ.* May 1850.
[3] *Pharmaceutical Journal*, vol. iv. p. 310.

2. **UNGUENTUM IODINII COMPOSITUM,** L. D.; *Unguentum Iodinei*, E.; *Compound Ointment of Iodine; Ointment of Ioduretted Iodide of Potassium.* (Iodine, ʒss.; Iodide of Potassium, ʒj.; Rectified Spirit, fʒj.; Lard, ℥ij.; First rub the iodine and iodide of potassium with the spirit, then mix with the lard, *L.*—The *Edinburgh College* omits the spirit, but uses the same proportions of the other ingredients. The *Dublin College* also omits the spirit, and substitutes ointment of white wax for lard.)—This ointment is employed in bronchocele, enlargement of the lymphatic glands, &c.

3. **TINCTURA IODINII COMPOSITA,** L. D.; *Compound Tincture of Iodine.* (Iodine, ℥j.; Iodide of Potassium, ℥ij.; Rectified Spirit, Oij. Macerate until they are dissolved, and strain. The *Dublin College* orders the same proportions, but one half of the above quantities.)—This solution may be mixed with water without any deposition of iodine. The dose at the commencement is ♏x., which may be gradually increased to fʒj. or more. When wine is admissible, sherry is a good vehicle for its exhibition.

4. **LIQUOR POTASSII IODIDI COMPOSITUS,** L. D., *Compound Solution of Iodide of Potassium; Solution of Ioduretted Iodide of Potassium.* (Iodide of Potassium, grs. x.; Iodine, grs. v.; Distilled Water, Oj. Mix, that they may be dissolved.) The proportions of the *Dublin College* are the same.—It is a brown-coloured solution, having the peculiar smell and taste of iodine. It may be diluted with water without suffering any change. It may be usefully employed in the diseases of children.—Dose for adults, from fʒij. to fʒvj., or even beyond this. One fluidounce of this solution contains only half a grain of iodide of potassium and a quarter of a grain of iodine.

The *liquor iodinei compositus*, Ph. Ed. consists of Iodine, ʒij.; Iodide of Potassium, ℥j.; Distilled Water, f℥xvj. Dissolve the iodide and iodine in the water with gentle heat and agitation.—This preparation, therefore, though agreeing in the nature of its ingredients with the *liquor potassii iodidi compositus*, Ph. L. differs very considerably in its strength. A fluidounce of it contains thirty grains of iodide of potassium and seven grains and a half of iodine: so that it contains sixty times as much iodide of potassium, and thirty times as much iodine, as the corresponding preparation of the London Pharmacopœia.—Dose, ♏x. to ♏xv.

5. **EMPLASTRUM POTASSII IODIDI,** L.; *Iodide of Potassium Plaster.* Take of Iodide of Potassium, ℥j.; Prepared Frankincense, ℥vj.; Wax, ʒvj.; Olive Oil, two fluidrachms. To the frankincense and wax melted together add the iodide, previously rubbed with the oil, and stir constantly till they have cooled. The plaster is to be spread on linen, rather than on towed leather.[3]

---

[1] *Pharmaceutical Journal*, 1849–50, p. 501; quoted from *Jahrbuch für prakt. Pharm.*

[2] *Ibid.* vol. iii. p. 545.

[3] Phillips's *Translation of the London Pharmacopœia*, 1851, p. 185.

6. SOLUTIONES POTASSII SUPERIODIDI; *Solutions of Superiodide of Potassium; Solutions of Ioduretted Iodide of Potassium.*—Solutions of ioduretted iodide of potassium, of various strengths, have been employed for different purposes by Lugol.[1] The following are the most important:—

α. *Lugol's Concentrated Solution of Iodine in Iodide of Potassium* consists of Iodine, ℈j.; Iodide of Potassium, ℈ij.; Distilled Water, ℥vij. Mixed with 3 pints and 13 fluidounces of water, it forms a solution equal in strength to the *Liquor Potassii Iodidi compositus*, L.

β. *Lugol's Ioduretted Mineral Water* is prepared of three degrees of strength:—

	No. 1.		No. 2.		No. 3.
Iodine……………………	gr. ¾	………	i.	………	i¼
Iodide of Potassium ………	gr. 1½	………	ii.	………	ii½
Distilled Water ……………	℥viii.	………	℥viii.	………	℥viii.

The solutions are yellowish or orange-coloured, and are quite transparent. When sweetened, they are readily taken by children; but the sugar should be added at the time of administration, as in the course of a few hours it effects a chemical change in the solutions. From six to eight ounces should be taken daily.

γ. *Lugol's Caustic, Rubefacient, and Stimulant Solutions* are composed of the same ingredients, but in different proportions.

	Stimulating Washes.			Rubefacient Solution.	Caustic Solution.
	No. 1.	No. 2.	No. 3.		
Iodine ……………………	gr. ii.	gr. iii.	gr. iv.	ʒiv.	℥i.
Iodide of Potassium ………	gr. iv.	gr. vi.	gr. viii.	℥i.	℥i.
Distilled Water ……………	lb. i.	lb. i.	lb. i.	℥vi.	℥ii.

Lugol uses the stimulating washes in scrofulous ulcers, ophthalmia, fistulous abscesses, &c. When the scrofulous surfaces require stronger excitement than usual, he employs the rubefacient solution. In tuberculous tumors which have obstinately resisted all other forms of treatment, the rubefacient solution may be applied in admixture with linseed meal (forming the *ioduretted cataplasm* of Lugol). To prepare the mixture, the poultice is first made in the ordinary manner; and when moderately cool, a sufficient quantity of the rubefacient liquor is poured on it with a wooden measure. The caustic solution is used for touching the eyelids and nasal fossæ, to repress excessive granulations (see also *Embrocatio Iodinii*, p. 411).

[A combination of Iodine and Iodide of Potassium has been found by Dr. Churchill to be a useful application as a caustic in the treatment of congestion, abrasion, or ulceration of the os uteri. His formula is as follows:—Pure Iodine, ʒx.; Iodide of Potassium, Distilled Water, and Rectified Spirit, of each ʒxx. Dr. Churchill commences the treatment by the application of nitric acid or of the acid nitrate of mercury. After a few days he employs the iodine solution, which he smears over the neck of the uterus with a brush. The application is repeated once, or at most twice, during the week. Under the influence of this solution, the neck of the uterus decreases in size, loses its sensibility, and the abrasions diminish in extent. Two months are generally sufficient to effect a cure, even in cases in which the congestion is very great. The application is continued for a certain time,—the period that elapses between the applications being gradually lengthened.[2]—ED.]

7. BALNEUM POTASSII SUPERIODIDI; *Bath of Superiodide of Potassium; Ioduretted Bath.*—Lugol employed baths of this kind in the treatment of scrofula. They should be made in wooden vessels.

---

[1] Lugol's *Essays on the Effects of Iodine in Scrofulous Diseases*, translated by Dr. O'Shaughnessy, p. 167, Lond. 1831.

[2] *Medical Times and Gazette*, Sept. 2, 1854, p. 246.

IODURETTED BATHS FOR CHILDREN.				IODURETTED BATHS FOR ADULTS.			
Age.	Water.	Iodine.	Iodide of Potassium.	Degree.	Water.	Iodine.	Iodide of Potassium.
	(Quarts)	(Troy Grs.)	(Troy Grs.)		(Qrts.)	(Drachms Troy)	(Drachms Troy)
4 to 7	36	30 to 36	60 to 72	No. 1	200	2 to 2½	4 to 5
7 to 11	75	48...60...72	96...120...144	No. 2	240	2...2½...3	4...5...6
11 to 14	125	72...96	144...192	No. 3	300	3...3½	6...7

49. POTASSII BROMIDUM.—BROMIDE OF POTASSIUM.

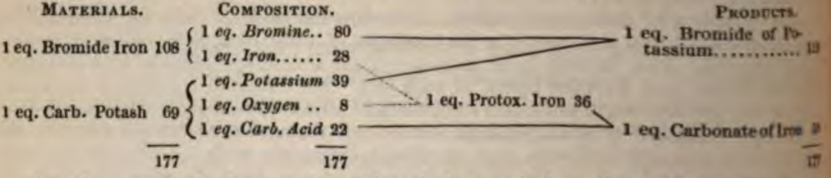
Formula KBr. *Equivalent Weight* 119.

HISTORY.—This salt, also called *hydrobromate of potash*, was first described by Balard in 1826.[1]

PREPARATION.—[It no longer finds a place in the Materia Medica of the British Pharmacopœias, but the history of this salt is of sufficient interest to justify the retention of the article prepared by the author. The processes for the preparation of the Iodide are equally applicable to it. In the former London Pharmacopœia the directions for its preparation were as follows :—]

Take of Bromine, ℥ij.; Carbonate of Potash, ℥ij. and ʒj.; Iron Filings, ℥j.; Distilled Water, Oiij. First add the iron, and afterwards the bromine, to a pint and a half of the distilled water. Set them by for half an hour, frequently stirring with a spatula. Apply a gentle heat, and when a greenish colour occurs, pour in the carbonate of potash, dissolved in a pint and a half of water. Strain and wash what remains in two pints of boiling distilled water, and again strain. Let the mixed liquors be evaporated, so that crystals may be formed.

In this process bromide of iron is first formed, $Br+Fe=FeBr$: this is afterwards decomposed by carbonate of potash, by which protocarbonate of iron and bromide of potassium are produced. $FeBr+KO,CO^2=KBr+FeO,CO^2$.



Another method of procuring this salt is to mix bromine with a solution of caustic potash, by which bromide of potassium and bromate of potash are formed. The bromate of potash may be converted into bromide of potassium by heat or by hydrosulphuric acid (see *Iodide of Potassium*, p. 514).

PROPERTIES.—This salt crystallizes in whitish transparent cubes or rectangular prisms. It is inodorous; its taste is pungent, saline, and similar to common salt, but more acrid. It is permanent in the air. When heated it decrepitates, and at a red heat fuses without suffering decomposition. It is very soluble in both cold and hot water, and slightly so in rectified spirit.

---

[1] *Ann. de Chim. et de Phys.* xxxii.

Characteristics.—That this salt is a *bromide* is known by the characters before mentioned for this class of salts. That its base is potassium (or potash) is shown by the tests for this substance.

COMPOSITION.—It consists of bromine and potassium in the following proportions:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Liebig.*	*Balard.*
Bromine	1	80	67·22	67·42	65·56
Potassium	1	39	32·78	32·58	34·44
Bromide of Potassium	1	119	100·00	100·00	100·00

The crystals may contain water lodged mechanically between their plates, but no combined water (water of crystallization).

PURITY.—The purity and goodness of this salt may be known by the following characters:—The form of the crystals, their freedom from colour, and their neutrality with respect to litmus and turmeric. A solution of this salt should give no precipitate with chloride of barium, thus showing the absence of carbonates and sulphates. The method employed by Rose[1] for detecting minute quantities of the chlorides in bromides, is the following:—If pure bromide of potassium, mixed with excess of bichromate of potash, be distilled with concentrated sulphuric acid in a tubulated retort, to which is adapted a receiver containing excess of solution of caustic ammonia, pure bromine distils over, and the ammoniacal liquor, which contains only hydrobromate of ammonia, remains perfectly colourless. But if the bromide contained a chloride, both bromine and the bichromate of the chloride of chromium distil over ($2CrO^3, CrCl^3$) or Chloro-chromic acid (CrO^2Cl), and the ammoniacal liquor becomes yellow, owing to the presence of some chromate of ammonia: chromic acid may be detected in the solution by the usual tests.

Commercial bromide of potassium frequently contains *iodide of potassium.* I detected it in bromide, the produce of the iodine works of Normandy. To recognise the iodide, place some crystals of the suspected bromide on a plate with some solution of starch, and cautiously add a minute portion of diluted nitric acid: the blue iodide of starch is produced. If much nitric acid be employed, the blue colour disappears, owing to the evolution of bromine and the formation of bromide of iodine, which does not act on starch. Lassaigne[2] used chlorine instead of nitric acid. He states that though bromide of iodine does not act on starch paper, yet if the paper be exposed to the air, the wetted part becomes successively red, violet, and blue; the organic matter of the paper probably decomposing the bromide of iodine and enabling the iodine to act on the starch.

The characters of good bromide of potassium are as follows:—

Totally dissolved by water. It does not alter the colours of litmus or turmeric. Chloride of barium throws down nothing from the solution. Sulphuric acid and starch added together, render it yellow. Subjected to heat, it loses no weight. Ten grains of this salt are capable of acting upon 14·28 grains of nitrate of silver, and precipitating a yellowish bromide of silver, which is dissolved by ammonia, and but very little by nitric acid.

If more nitrate of silver than the quantity above stated be decomposed by the bromide, the presence of a chloride may be suspected.

---

[1] *Journ. de Pharm.* t. xxiii. p. 489.

[2] *Pharmaceutical Journal*, vol. ii. p. 363.

Physiologic
not been ascert
β. *On Anim*
water, and inje
caused convulsi
introduced a d
effects, save vo
killed dogs in
gullet, with n
Maillet[2] gave t
that, according
horse should be
would have no i
γ. *On Man.*
investigation.
Dr. Williams[3]
months, without
14 years old, af
for several week
and a few dro
obtained, showi
but little benefit
irritable conditi
Three cases are
of the bowels, n
and even then it
tinued use of i
lymphatic glands
mercury, and t
Williams thinks
cure of diseases
sesses narcotic a
These seldom a
the remedy in d
period of fifteen
siness soon follow
of idiocy, mingle
way, and with it
seldom carried to
causes sufficient i
are rare. It can
above described c
of organic life are
of purgatives. C
completely annihi

---

[1]
[2]
[3]
[4]

an extent, that these parts may be tickled without exciting the least effort at deglutition.—ED.]

USES.—In 1828, Pourché[1] employed this salt with benefit in the treatment of bronchocele and scrofula: it was taken internally, and applied externally in the form of ointment. In 1836 it was introduced into the London Pharmacopœia, in consequence of the great success obtained from the use of it in a case of enlarged spleen under the care of Dr. Williams.[2] In this, and in three other successful cases of the same disease, it was used internally only. Dr. Williams also gave it with success in a case of ascites. Magendie[3] employs it as an anti-scrofulous remedy, as an emmenagogue, and against hypertrophy of the ventricles. Prieger[4] applied it externally in the form of ointment in tinea capitis.

ADMINISTRATION.—It is exhibited in the form of a pill or solution in doses of from four to ten grains three times a day.

ANTIDOTES.—In a case of poisoning by this salt the treatment may be the same as for iodide of potassium.

UNGUENTUM POTASSII BROMIDI; *Ointment of Bromide of Potassium.*—This is composed of from ℈j. to ʒij. of bromide to ℥j. of lard. Bromine is sometimes added.

[50. POTASSII CYANIDUM.—CYANIDE OF POTASSIUM.]

Formula KCy; or K,C^2N. *Equivalent Weight* 65.[5]

[This compound is not met with in the Pharmacopœias of the British Colleges.

PREPARATION.—It may be procured by heating the finely powdered ferrocyanide of potassium to bright redness in a covered iron vessel, and letting it cool excluded from air. The porous fused mass should be broken up, put into a glass funnel, moistened with rectified spirit, and then lixiviated with cold water. The first runnings are colourless and highly concentrated: they should be rapidly evaporated to dryness, and fused in a porcelain vessel. Alcohol of 60 per cent (sp. gr. ·896) readily dissolves cyanide of potassium at its boiling point, but lets nearly the whole fall on cooling: stronger or weaker alcohol retains much more in permanent solution.[6]

The decomposition of the ferrocyanide by heat may be thus simply expressed. This salt may be considered to consist of two equivalents of cyanide of potassium and one equivalent of cyanide of iron 2KCy + FeCy. By heating it in a covered vessel, the cyanide of potassium is unaffected, while the cyanide of iron is converted into an insoluble compound of carbon and iron. Care must be taken that the heat is carried sufficiently high for the decompositon, or some ferrocyanide of potassium will remain and give a yellow colour to the lixivium. In this case a separation may be made by warm alcohol, which readily dissolves the cyanide but not the ferrocyanide.

---

[1] *Journ. de Chim. Méd.* t. iv. p. 594.

[2] *Op. cit.*

[3] *Formulaire*, 8me édit. 1835.

[4] Dierbach, *Die neusten Entdeck. in der Mat. Med.* 1837.

[5] [Potassium is generally taken at 40. This would make the equivalent of the cyanide 66. The author, however, adopts throughout the integer of 39 for potassium: hence, to preserve uniformity, the equivalent weight of the cyanide is placed at 65.—ED.]

[6] Brande's *Manual of Chemistry*, vol. i. p. 599.

There are m
In fact, whene
with potassium
this for the pu
where (*ante*, p
the substance
ever, the suspe
into a small tu
heat applied so
cyanide of pota
and combining
be removed fro
off clear or filt
added, the mi
acid: Prussian
cyanogen deriv
process easily

Properties.
crystallized in
cyanic acid, an
kept exposed t
excluded both
vided air be exc
verted to cyana
forms an admir
reduces them;
barium. The c
reaction, and is
the salt being r
double salts wit
and some other
largely employe
well as in photo

Characteris
hydrocyanic aci
an acid. The p
applying to the

If a small qu
and the liquid a

Composition.
proportions:—

Cyanogen (N
Potassium ..

Purity.—Th
soluble in water

[1 Cyanide of pot
openings at the botto
this case may possibly

This is indicated by effervescence with acids, and also by the carbonate being left undissolved by alcohol. It should remain white when calcined; if it blackens, this indicates, according to Liebig, that the salt is contaminated with formiate of potash. Nitrate of silver produces a white precipitate (cyanide of silver) in an aqueous solution, but this precipitate is redissolved by an excess of the cyanide. It is this which forms the silver-solution used for the deposition of silver by galvanism on metallic and other surfaces.

PHYSIOLOGICAL EFFECTS. α. *On Vegetables.* The action of this salt on plants has not been made the subject of experiment.

β. *On Man and Animals.* The cyanide of potassium acts as a most powerful poison, and produces the symptoms and effects caused by large doses of prussic acid. Hence it has not been employed as a medicine in this country. It possesses no advantage over hydrocyanic acid, which may be given with safety and in regulated doses. Continental practitioners, however, have resorted to its use in cases of neuralgia and in nervous affections of the organs of circulation and respiration. In foreign pharmacopœias it is described as being better adapted for the prescriber's use than prussic acid, because, unlike the latter, it does not evaporate and is not liable to change. On this it may be remarked, that the diluted hydrocyanic acid of the British pharmacopœias undergoes no change by keeping, while the cyanide, as it has been already stated, cannot be brought in contact with air or water without being decomposed.

The poisonous effects of this compound are unfortunately too well known among the cases reported we quote the following :[1]—

> “A physician prescribed for a patient rather more than one drachm of the cyanide in two ounces and a half of orange-flower water and syrup; and of this mixture three spoonfuls were to be taken daily. It seems that table-spoonfuls were taken, and the patient died in three-quarters of an hour after the first dose. None of the poison was found in the stomach; but a portion of the mixture from which the dose had been taken was examined and found to contain cyanide of potassium. A criminal procedure was instituted against the physician, and he was fined and imprisoned. M. Malaguti, who gave evidence on the occasion, stated that a dog was killed in a few minutes after taking less than three grains of the cyanide in solution; and that the largest medicinal dose of this substance to a human being was five-sixths of a grain.[2] The mixture in the above case contained about three grains of the cyanide in one drachm: therefore, had tea-spoonfuls been taken by the deceased he would have taken quite sufficient to destroy life. The medicine had evidently been prescribed by a person totally ignorant of its poisonous properties. Another case occurred at Breslau, in which a man, aged thirty, died in a *quarter of an hour* under all the symptoms of poisoning by prussic acid, after taking a dose of a mixture containing fifteen grains of cyanide of potassium, which had been prescribed for him by his medical attendant.[3]

Cases of poisoning by this agent have been rather frequent of late years. The cyanide of potassium is much used as a solvent for silver, and is largely employed by coiners for covering base metal. In most of the cases the poison has proved so rapidly fatal, that the persons have died before they were seen by a medical practitioner. The symptoms have not, therefore, been observed; but, so far as we can form a judgment, they are identical with those produced by prussic acid.[4]

It has been supposed that the cyanide of potassium might exist in the state of *vapour*, and destroy life by its accidental introduction into the lungs. When this salt is exposed to a damp atmosphere, or is acted upon by acids, hydrocyanic acid freely escapes, and the respiration of this vapour may produce injurious, or even fatal effects. It does not appear

---

[1] Taylor's *Medical Jurisprudence*, 5th edit. 1854, p. 172-4.

[2] *Lancet*, January 1843.

[3] Henke, *Zeitschrift der S. A.* 1843, p. 7; see also *Ann. d'Hyg.* 1843, tom. i. p. 404.

[4] *Medical Times*, October 12, 1850, p. 390; also Nov. 9, 1850, p. 482; and July 12, 1851, p. 41.

probable, howev
In December, 1
remarkable circu
to bed in their
the following m
abutted on one
some noxious va
in the house-wal
noxious agent in
not volatile und
spread itself in
the deceased w
or nitrogen from
that no carbonic
ceivable that a s
diffused in the f
its detection in
respiration of th

Uses.—The
the extempora
solution of a s
As we have els
by other and m
It is chiefly e
the compositio
removal of stai
the black mark
ink. The sta
potassium, and
Administra
milligrammes (
pill or draught.
solution, a syru
of the cyanide.

[51. POTAS

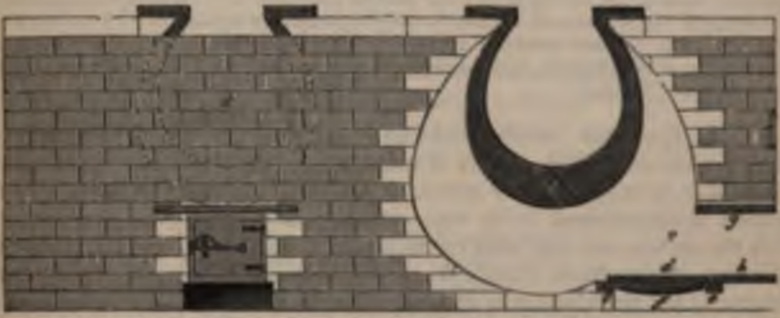
Formula K²Cfy

History.—T
macopœias of t
preparation of
test. It was ac
It has had a v
prussiate of Po
Preparation.
an egg-shaped i
good pearl-ash a
in the proportio

---

well with a flat iron paddle. The mixture, as it is calcined, will gradually assume a pasty form, during which transition it must be tossed about with much manual labour and dexterity. When the conversion into a chemical compound is seen to be completed by the cessation of the fœtid animal vapours, remove the pasty mass with an iron ladle. If this be thrown, while hot, into water, some of the Prussic acid will be converted into ammonia, and of course the usual product diminished. Allow it to cool, dissolve it in water, clarify the solution by filtration or subsidence, evaporate, and, on cooling, yellow crystals of the ferroprussiate of potash will form. Separate these, re-dissolve them in hot water, and by allowing the solution to cool very slowly, larger and very regular crystals may be had."[1]

FIG. 84.



Egg-shaped Iron Pots and Furnaces used for the Manufacture of Ferrocyanide of Potassium.

a. Front view of furnace, with pot.
b. Section of pot *in situ*.
c. Fire-place.
d. Fire bar.
e, e. Bearing bars.
f. Ash-pit.
g. Bearing plate.
h. Dead plate.

"Mr. Charles Mackintosh, of Glasgow, who is one of the largest manufacturers of this salt, informs me that the animal matters employed as the source of cyanogen are chiefly chips of horns, animal hoofs, woollen rags, and the substance called *greaves*, which is the refuse of tallow-melters, and consists chiefly of cellular membrane from which the fat has been expressed: these are burned, and in fact fused at a very high heat with potash, to form what is called *prussiate cake;* this, when cold, is lixiviated with water, and the evaporated solution yields a first crop of very impure ferroprussiate; it is re-dissolved, and the second crystallisation is allowed to go on very slowly, it being at least a fortnight before the contents of the coolers are disturbed. The iron requisite to the constitution of this salt is derived from the iron pots and stirrers used in the operation, or, if requisite, iron filings are added" (Brande).

The following explanation of the theory of this process is from Liebig.[2] When animal substances containing carbon and nitrogen are fused with potash at a red heat, the potassium is reduced by the carbon, and forms by its reaction on the other ingredients cyanuret of potassium. The fused mass at a red heat contains no ferrocyanogen, but iron and carburet of iron in the form of a suspended powder. When it is lixiviated with cold water and immediately evaporated, it furnishes no ferrocyanuret; but when the solution is gently heated for several hours in the contact of air, oxygen is absorbed, it acquires a yellow colour, and now contains much ferrocyanuret of potassium. This explains why a

---

[1] Ure's *Dictionary of Chemistry*.

[2] *Phil. Mag.* for June 1841; also *Proceedings of the Chemical Society*, p. 2.

solution of cyanu
metallic iron abso
and dissolving th
cyanogen with wh
bine with the rem
potassium. In cl
gen. The fused r
of potassium, dec
stances are fused
decomposed by bo
formed being in p
The best way o
is to treat one-thi
long as a precipit
heat the whole to
position, and the
cyanuret. The c
sulphocyanuret of
mother liquor (B

Mr. L. Thon
formed when a
iron filings, is e
potassa is dec
with the carbon
cyanuret of po
process to the
Properties.-
parent, perman
with a square b

Truncated Octoh
I

They have a pec
Their sp. gr. is
They are insolu
When moderate
tion, and are co
potassium). W
of the salt is dec
oxide of iron, an

ammonia are evolved, while the residue consists of sesquioxide of iron and carbonate of potash.

Characteristics.—A solution of this salt throws down, with the protosalts of iron, a white precipitate (*ferrocyanide of potassium and iron*), which by exposure to the air becomes blue (***Basic Prussian Blue***). With the persalts of iron it forms a deep blue (***Prussian Blue***); with the salts of copper a deep brown (***Ferrocyanide of Copper***); and with those of lead a white precipitate (***Ferrocyanide of Lead***). Heated with dilute sulphuric acid, hydrocyanic acid is evolved, and a white precipitate formed, which, by exposure to the air, becomes blue. Hydrosulphuric acid, the sulphurets, alkalies, or tincture of galls, give no precipitate with a solution of this salt; showing that the iron which it contains is in some remarkable state of combination. If a solution of the ferrocyanide of potassium be boiled with red oxide of mercury, percyanide of mercury is formed in the solution, and a mixture of sesquioxide and cyanide of iron is precipitated. The presence of potassium is best shown by calcining the salt, and detecting potash by the usual tests in the residuum.

COMPOSITION.—Crystallised ferrocyanide of potassium has the following composition:—

	At.	*Eq. Wt.*	*Per Cent.*	Or,	*At.*	*Eq. Wt.*	*Per Cent.*
Cyanogen	3	78	36·620	Cyanide of iron	1	54	25·35
Iron	1	28	13·145	Cyanide of potassium	2	130	61·97
Potassium	2	78	37·560				
Water	3	27	12·675	Water	3	27	12·67
Crystallised Ferrocyanide Potassium	1	211	100·000		1	211	99·99

Of a yellow colour. It is dissolved by water. Any alkali or tincture of galls added to this solution produces no change. What is thrown down by protosulphuret of iron is at first white, but speedily becomes blue. Sulphate of copper throws down a red brown, and sulphate of zinc a white precipitate. It loses its colour by a gentle heat, and 100 grains lose 12·6 grains of water. It is decomposed by a red heat. The residue is soluble in hydrochloric acid, and this solution is again precipitated by ammonia. From 100 grains 18·7 grains of sesquioxide of iron may be thus obtained. Lastly, if boiled with diluted sulphuric acid it evolves the odour of hydrocyanic acid.—*Ph. Lond.*

PHYSIOLOGICAL EFFECTS. α. *On Animals.*—Schubarth[1] gave two drachms to one dog, and half an ounce to another, without observing any injurious consequences. Callies[2] found the commercial ferrocyanide of potassium slightly poisonous, but when prepared with care he remarked that several ounces might be given with impunity. These and other experiments show that this salt possesses very little activity. The rapidity with which it is absorbed and gets into the secretions, as the urine, is most remarkable. Westrumb[3] recognised it in the urine in from two to ten minutes after it was taken into the stomach. Hering[4] has shown the amazing rapidity with which it traverses the body when it once gets into the blood. Thus, when it was placed in one jugular vein of a horse, he recognised it in the opposite one in from twenty to thirty seconds.

β. *On Man.*—It has no great influence on man. D'Arcet swallowed half

---

[1] Wibmer, *Wirk. d. Arzneim.*

[2] Wibmer, *op. cit.*; also Christison's *Treatise on Poisons.*

[3] Muller's *Physiology*, by Baly, vol. i. p. 247.

[4] *London Medical Gazette*, vol. iv. p. 250.

a pound of a
"Similar resul
smaller doses b
Macneven and
might be taken
Dr. Smart,[3]
that its primar
fulness and fre
healthy person,
ten beats in a
state of the s
effects are muc
cases accompan
and astringent,
some cases, he
of the gums, b
An over-dose,
sense of gastri
Further eviden
not accord with
USES.—Hith
ployed it as a s
morbid sensibili
in inflammation
disease it lesse
dyspnœa. As a
speaks highly of
sweating in chro
and to allay dia
ADMINISTRAT
grains, given in
much as forty g
doses may be gi

[52. Potassi

[This salt has be
seen in brilliant ru
monly known unde
It is prepared b
potassium until th
should then be filte
prismatic crystals.

1
2
3
4

Ferridcyanogen and Ferridcyanic acids are isomeric with Ferrocyanogen and Ferrocyanic acids, the equivalent of the two former being twice as great as that of the two latter.

PROPERTIES.—The crystals are known by their ruby-red colour; they are slightly efflorescent. They are soluble in about four parts of water, but are insoluble in alcohol. They burn with brilliant scintillations, and when heated in close vessels give off cyanogen and nitrogen, and leave ferrocyanide of potassium and carburet of iron. The solution in water is of a yellowish colour: it gives a deep blue precipitate with protosalts of iron (Turnbull's blue), but does not precipitate a persalt. It gives merely an olive-green colour. The solution of this salt is decomposed by hydrosulphuric acid; sulphur and cyanide of iron are precipitated, and hydryocyanic acid and ferrocyanide of potassium are formed.

The salt is thus constituted :—

	Atoms.	*Eq. Wt.*	*Per Cent.*
Potassium	3	117	36·14
Ferridcyanogen	1	212	63·86
Ferridcyanide of Potassium	1	329	100·

It is not put to any use in pharmacy or medicine.—ED.]

53. POTASSÆ NITRAS.—NITRATE OF POTASH.

Formula KO,NO^5. *Equivalent Weight* 101.

HISTORY.—At what time this salt became known it is now difficult to determine. As it is found in various parts of the East, on the surface of the earth, it appears probable that it must have been known at a very early period. Furthermore, if the Chinese and Hindoos were acquainted with the art of making gunpowder and fireworks at a very early period of history, they must have employed, and, therefore, been acquainted with, nitre. Geber,[1] however, is the first who distinctly mentions it. He describes the mode of making nitric acid from it. But the terms *neter* of the Old Testament,[2] translated *nitre*, —*νίτρον* (Attice, λίτρον) of Herodotus[3] and Theophrastus[4]—and *nitrum* of Pliny,[5] appear to have been applied to *natron*.[6] It is probable, however, that the ancients also included under this name nitre (likewise nitrate of lime, according to Harless[7]), which they confounded with carbonate of soda. The term *aphronitrum* (ἀφρονίτρον), or *aphrolitrum* (ἀφρολίτρον), was applied to the softer and more spongy sorts of nitrum; while the phrases *spuma nitri* and *flos nitri* were applied to the nitrum in a superficial or efflorescent form.[8] The word *saltpetre*, usually applied to nitre, is evidently derived from *sal petræ*, literally signifying rock salt.[9] It is sometimes used in a general sense to signify a nitrate used in the arts; and the particular kind intended to be designated is then distinguished by the name of the base or by the shape of the crystal: and thus nitrate of potash is sometimes called *potash-saltpetre* or *prismatic nitre*, to distinguish it from *soda-saltpetre*, also termed *cubic*

---

[1] *Invention of Verity*, ch. xxiii.

[2] *Proverbs*, ch. xxv. 20; *Jeremiah*, ch. ii. 22.

[3] Book ii. (*Euterpe*), chap. lxxxvii.

[4] *De Igne*.

[5] *Hist. Nat.* xxx. i.

[6] See Beckmann's *History of Inventions and Discoveries*, vol. iv.

[7] *Janus*, Bd. i. S. 454, Breslau, 1846.

[8] Paulus Ægineta, by Adams, vol. iii. pp. 62, 63, and 231.

[9] See *Sodæ Carbonas* and *Sodæ Sesquicarbonas*.

nitre, or in t
When, howe
nitrate of pot
NATURAL

a. IN THE IN
other parts of
found in the soi
of the soil by e
incrustation upo
been usually su
and oxygen of t
probable that it
of the atmosphe
The simultaneo
nitrogen. The
to be a condit
necessary than
without animal
being found in s
be forgotten, t
long since finish
longer going on
exist" (Knapp).
β. IN THE O
found in tobacco
and *Geum urban*

PRODUCTIO
by the purific
world it is pr
nitre; that is
localities whic
duction of thi
vention of ma
1. *From n*
ductive of nitr
parts containi
the soil analys

Matter ins
Matter solu

Matter solu

Extraction.

---

[1] Liebig, *Organ*
L. Playfair, Lond.
[2] "Supposing ev
2600 lbs. of cow-du
of saltpetre." (Kna
[3] *Account of the*
[4] De Candolle, *P*
p. 114.
[5] *Journ. of the A*

facturers of saltpetre, commence their operations by scraping off the surface from old mud-heaps, mud-buildings, and waste grounds, where the saltpetre has developed itself in a thin white efflorescence, resembling frost-rind. This saline earth being collected at the factories, the operator first subjects it to the process of solution and filtration. This is effected by a large mud filter, lined on the inside with stiff clay." It has a false bottom of bamboo, covered with close wrought grass mats, on which are placed vegetable ashes. Upon these the nitrous earth is laid. Water is then added to dissolve the saline matters of the earth, and the solution thus obtained, fitering through the mats, drops into the empty space between the real and false bottom, and is conveyed away into an earthen receiver. In its passage throught the wood-ashes, the carbonate of potash contained in the latter reacts on the nitrate of lime of the solution, and produces nitrate of potash and carbonate of lime. The solution is afterwards evaporated in earthen pots, filtered, and put aside to crystallise. The impure nitre thus procured is termed *dhouoh:* it contains from 45 to 70 per cent. of pure nitrate of potash. It is redissolved and crystallized by the native merchants, who supply the Calcutta bazaars; and when thus purified is called by the natives *kalmee*.[1]

Rough nitre.—Saltpetre is imported into this country principally from Calcutta, but some also comes from Madras. It is brought over in cloth bags, which contain from 150 to 175 lbs. each. Its quality varies considerably. It is always more or less impure: but the common varieties, which have a dirty yellowish appearance, are termed *rough* or *crude saltpetre*, or *grough petre;* while the purer and cleaner looking kinds are called *East India refined*. The loss which it suffers in refining—or, in other words, the impurities which it contains—are technically designated *refraction*. This varies greatly in different samples, but is usually between 5 and 15 per cent.

Estimate of the purity of rough nitre.—The degree of impurity or refraction of the rough nitre imported into this country is approximatively determined previous to sale, in order to enable the merchant or broker to estimate its value. Riffaut's humid method of analysis consists in washing the rough nitre with a saturated solution of pure nitrate of potash: this dissolves the chlorides and leaves the nitre, which is dried and weighed. From this 2 per cent. must be deducted for the nitre deposited from the solution whilst taking up the chlorides. Gay-Lussac's method consists in converting the nitrate into carbonate of potash, by fusing it with charcoal and (to moderate the reaction) with common salt, and estimating the quantity of alkali present. Another method is to dry the salt, by which the amount of water present is estimated; to dissolve in water, and thereby to estimate the quantity of insoluble substances; to test the solution with nitrate of silver, nitrate of baryta, and oxalate of ammonia, in order to form a general notion of the impurities; and lastly, to crystallise the soluble salts: the experienced eye readily detects the foreign salts present, such as nitrate of soda, sulphate of potash, sulphate and nitrate of lime, and chlorides of potassium, sodium, and calcium. Husz's physical method has been introduced by him in Austria: it consists in ascertaining the temperature at which a cooling solution of nitre begins to deposit crystals: this is fixed, and depends on the relative proportion

---

[1] See Stevenson, *op. cit.*; also *India Journal of Med. and Phys. Science*, new series, vol. i. p. 10, 1836.

of water to tha
Gossart's meth
acid required t
the salt which
coarsely fibrous
Purification
dissolving it in
liquid has been
cloth, and setti
the crystallisati
crystallised onc
refined[2] (*nitr*
with nitrate of
detects the chlo
salts.

The *Dublin Col*
prepared: — Take
quantity. Having
let the heat be wit
the salt may be ob
the uncrystallised
earthenware perco
through ceases to
The contents of th

[No process i
salt is placed as
2. *Cultivate*
cultivated; that
the intervention
produced; and t
artificial nitra
tations. The c

1. The presen
as marl, c
2. The presen
3. A temperat
4. Access of a
5. The presen

Light, perhaps, f
The mode of p
places, according
nitre is formed fr
into this is put a

---

[1] For further detai
Chemistry; and Knap
[2] Colonel Moody in
has about 3 per cent. r
for the manufacture of
[3] For full details of
1827; Dumas, *op. sup*
Annalen, xxix. p. 272;

running from the stables. In two or three years this earth yields nitre. In Sweden,[1] where each landed proprietor is compelled to furnish a certain quantity of nitre, it is prepared as follows :—Decomposing animal and vegetable matters, mixed with cinders, lime, or marl, are placed in heaps (called *nitre beds*) under cover, the mass being occasionally moved, or holes made in it, so that they are exposed to the air. From time to time they are watered with urine. At the end of two or three years the nitrogen has combined with oxygen, and this with the bases to form nitrates. By lixiviation the salts may be separated, and any nitrate of lime present may be converted into nitrate of potash by adding wood-ashes, which contain carbonate of potash. In Prussia, *nitre walls* are employed instead of nitre beds ; that is, the heaps are made with perpendicular sides, like walls. These have two advantages,—they economise land, and they expose a large surface to the air.[2] At Longpont, in France, a stone-quarry is used as a nitre-plantation, earth and dung being arranged in alternate layers, and the liquid manure from stables and houses being added to it. Thouvenal proposed the formation of *sheepfold-nitraria* (*nitrières-bergeries*), so that the manure of sheep might be used for nitrification.

The mode of extracting the nitre from the ripe earth may be easily understood. The earth is lixiviated, the crude lye boiled down, some potash salt (carbonate) added to decompose the nitrates of lime and magnesia and convert them into nitrate of potash, the clear liquid boiled down, and the crude saltpetre allowed to crystallise. In the subsequent refining process, glue is added to the lye to cause the separation of the extractive matter.

[3. *By chemical processes.*—Of late years many plans have been devised for the manufacture of this useful salt. Thus M. Weber, a German chemist, taking advantage of the fact that nitric acid displaces hydrochloric acid, prepares chemically pure nitrate of potash by the following process :—

The commercial nitrate is dissolved in the smallest possible quantity of boiling distilled water, and in order to separate the nitrate of lime, a solution of pure carbonate of potash or soda added as long as a precipitate is formed ; the liquid, filtered while hot, and as rapidly as possible, is then boiled, a small quantity of pure nitric acid[3] added, and the boiling continued, with occasional replacement of the evaporated water, until the liquid gives no longer any indication of chlorine with nitrate of silver, when it is to be evaporated to dryness. The excess of nitric acid added to the saline solution evaporates, or, when iron is present, is decomposed, and frequently communicates to the mass a yellow colour, which disappears on heating the salt sufficiently. When the saline solution gives no indication of chlorine, evaporation to dryness is unnecessary, and the excess of acid may be saturated with a solution of carbonate of potash or soda. In the opposite case, the dry mass must be re-dissolved in water, the solution filtered, and allowed to crystallise, when, if iron was present, it is left as oxide upon the filter. By this process it is said a very beautiful and pure product is obtained.[4]

Nitrate of potash may be prepared from nitrate of soda by placing two vessels, of which the upper contains nitrate of soda, and the lower carbonate of potash, over one another, and as soon as both solutions boil, the fire under the upper vessel is extinguished and the liquid allowed to flow into the lower one, when immediately hydrated carbonate of soda is precipitated, and the residual lye is allowed to flow into crystallising pans, and agitated, in order to obtain saltpetre-meal (salpeter-mehl), which is to be treated in the usual way.[5]—ED.]

---

[1] Berzelius, *Traité de Chimie*, t. iii. p. 391.

[2] Dumas, *op. cit.*

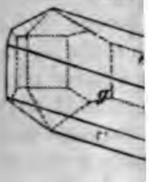
[3] About four fluidounces to every pound of nitrate.

[4] *Allgemeine Pharmaceutische Zeitschrift* ; also *Pharm. Journ.* June, 1853, p. 596.

[5] *Pharm. Central-Blatt*, No. 37, p. 592, 1851 ; also *Pharm. Journ.* 1851-2, p. 236.

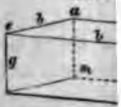
PROPERTIE

FIG.



Crystals (

FIG.



Primitive right

fuses, and wh
having former
prunella. A
oxygen and tl
powder and
nitrous acid a
dissolve 13·3
212°, they dis
pure alcohol,

Characteri
already detaile
the tests for tl

COMPOSITIO

	Atc
Potash............	1
Nitric acid	1
Nitrate of Potash	1

IMPURITIES.
or earthy chlor
been pointed
exposure to th
The presence o
communicates
crystalline forn
rhombic plate,

Soluble in wat
barium or nitrate
emits oxygen. F

---

[1] Levy, *Quarter*
for July 1840.

vapours. Thrown on burning coals it deflagrates, carbonate of potash being left. From one hundred grains digested in sulphuric acid are obtained eighty-six grains of sulphate of potash, dried at a red heat. If chloride of barium or nitrate of silver yield no precipitate, neither a sulphate nor a chloride is present.[1]—*Ph. Lond.*

[Common nitre is frequently contaminated with nitrate of lime. This may be known by adding oxalate of ammonia to the solution. The test should produce no precipitate if the nitre be pure.—ED.]

PHYSIOLOGICAL EFFECTS. *α. On Vegetables.*—Nitrate of potash, dissolved in 300 times its weight of water, promotes vegetation: but a solution containing $\frac{1}{16}$th part of nitre is injurious to the growth of plants.[2] Some interesting details on the use of alkaline nitrates are given by Mr. Johnston.[3] He says that they increase the production of woody matter of plants; but no well-ascertained facts have yet been obtained to determine the differential effects of the nitrates of potash and soda.

β. On Animals generally.—Orfila[4] found that when introduced into the stomachs of dogs it acted as an irritant poison. If administered in doses of two or three drachms, it is capable, when not vomited up, of causing death. Its operation is that of a narcotico-acrid poison. When applied to the cellular tissue it produces, according to this experimentalist, local effects only, and does not become absorbed. But Devergie[5] states, on the authority of J. E. M. Smith, that half an ounce applied to the thigh killed a dog in thirty-six hours. Eight ounces dissolved in a pint of water, and swallowed, killed a horse in twenty-four hours, with all the symptoms of violent intestinal irritation.[6] Veterinarians use nitre as a diuretic and refrigerant in doses of from two to four drachms.

γ. On Man.—In *very large doses* (such, for example, as one ounce or more), nitre has in several instances caused death;[7] but the effects of it are not uniform, since, in other cases, this quantity has not appeared to have any very remarkable or obvious effect. For example, Dr. Christison knew an instance in which one ounce was taken without occasioning any other unpleasant symptom than vomiting; and it was retained on the stomach for above a quarter of an hour. In a case reported by Mr. Gillard, a man recovered in four days from the use of two ounces of nitre taken by mistake for Epsom salts. In those cases where violent effects followed the ingestion of it, the symptoms were two-fold: on the one hand, those indicating irritation of the alimentary canal (such as pain, vomiting, and sometimes purging); —on the other, an affection of the nervous system (marked by giddiness, convulsions, failure of pulse, tendency to fainting, dilated pupil, insensibility, and palsy). In a case related by Dr. Geoghegan (quoted by Dr. Taylor), death occurred in two hours from an ounce and a half; in Orfila's case, one ounce caused death in three hours; and in another case, which occurred in Manchester, ten drachms caused diarrhœa and death in five hours. In other cases the death has been less speedy: in one instance it did not occur until sixty hours after the ingestion of an ounce and a half of the salt. It is

---

[1] Phillips's *Translation of the London Pharmacopœia*, 1850, p. 31.
[2] Davy, *Agricultural Chemistry*.
[3] *Lectures on Agricultural Chemistry*, p. 391, *et seq.* 2d edit.
[4] *Toxicol. Générale.*
[5] *Médecine Légale.*
[6] Moiroud, *Pharmacologie Vétérinaire*, Paris, 1831.
[7] See Dr. A. S. Taylor's work *On Poisons.*

probable tha
aqueous liqui
the less powe
reconcile the
ounce of nitre

In *moderat*
Its refrigerant
as in febrile di
experienced a
nise by the th
body. He fo
over the vascu
of time, the m
this salt, withi
60 beats. Di
urine, its oper
is communicat
Like most of t
alvine evacuati
a diaphoretic, i

Various effe
been already al
exercised by th
the coats of t
probable that
corpuscles, and
on the blood ha
effect has been
has suggested, t
effused product
the effused pla
Another effect w
on the blood, an
diminishing the
chemical effect i
It it be mixed w
cates to it a flori
stomach, becom
mixed with the
Stevens[3] asserts,
has this effect.
where a person s
salts, the blood w
as fluid as if the

---

[1] *Essays*, p. 105, *e*
[2] *London Medical*
[3] *Observations on t*
[4] For some remark
vol. viii. p. 626; and
vol. ii. p. 766.

[Dr. Löffler[1] relates a series of experiments with this salt, performed by five healthy students upon themselves. After from eight to twelve days' use of the medicine, in daily quantities increasing from one drachm to five drachms, the blood drawn from the veins presented the following characters:—1. In colour and density it resembled cherry-juice. 2. The number and size of the colourless blood-corpuscles were increased. 3. The blood-globules were paler in colour. 4. The blood coagulated very quickly. 5 Increased proportion of water, and corresponding diminution of the solid constituents of the blood. 6. Diminution of its fat. 7. Increased proportion of ash in serum. 8. Diminished firmness and elasticity of the crassamentum, the solid constituents of which were less in quantity than in normal blood. The symptoms observed were, general weakness and indisposition to exertion of body and mind, low spirits, slowness and feebleness of pulse, and paleness of face; the action of the bowels was for the most part healthy, but there were sometimes pain and purging.—ED.]

USES.—It follows, from what has been stated in regard to the physiological effects of nitre, that the use of this substance is indicated when we wish to diminish preternatural heat, and to reduce the force and frequency of the pulse, as in febrile disorders, inflammatory affections (except, perhaps, those of the stomach, bowels, kidneys, and bladder), and hemorrhages[2] (especially hæmoptysis). In continued fever it is frequently given in combination with emetic tartar, and sometimes also with calomel.

In acute *rheumatism*, large doses of nitre have been administered, apparently, in many cases, with great success. They were first employed about the middle of the last century by Dr. Brocklesby,[3] who gave this salt to the extent of ten drachms or more, dissolved in three, four, or five quarts of thin gruel in twenty-four hours. Within three or four days the malady was much relieved, or even cured, under great sweating. Until the last ten or twelve years, this method of treatment had for the most part fallen into disuse: it has, however, lately been revived, principally by some French physicians. According to Dr. Henry Bennet,[4] the revival is due to Gendrin. But Martin Solon (whose observations have been reported by Aran[5]), Stœber, Forget,[6] and others, have borne evidence to the success of the practice. Bouchardat,[7] however, observes that this method of treatment had been repeatedly tried in the practice of the Hôtel-Dieu; but either from the physicians of that hospital not finding it more efficacious than simple expectation, or because they feared the action of too energetic an agent, the trials of it were not long continued. Gendrin generally began by four drachms in the twenty-four hours with an adult female, and six drachms in the same period with an adult male; and he rapidly increased the dose to eight, ten, or twelve drachms, seldom carrying it further. Aran states that the mean quantity employed in twenty-four hours was about eight drachms, and that the mean quantity administered during the disease has been about twelve ounces!

---

[1] Schmidt's *Jahrbüch*. 1848; *Edinb. Monthly*, April 1848.

[2] Gibbons, *Medical Cases and Remarks*, Part II. *On Nitre in Hæmorrhagy*, 2d ed. Sudbury, 1811.

[3] *Œconomical and Medical Observations*, p. 116, Lond. 1764.

[4] *Lancet*, Feb. 10 and June 15, 1844.

[5] *Journal des Connaissances Medico-Chirurgicales*; also, *Ann. de Thérapeutique*, 1842.

[6] *Ann. de Thérap.* 1844.

[7] *Ibid.* 1842.

The salt shou
the eight drac
states that it
water, properl
to a pint and
copious swea
influence the
effects from it
fails to give a
Dr. Basham,[1]
excess of fibri
He recommen
given in the t
to be increase

[Dr. Rowla
of the disease
was eight days
later; in all, t
In no instance
salt is most m
In chronic rhe
not able to offe
half an ounce
smaller doses t
doses are given
cases.—Ed.]

It is not oft
very great; b
arterial exciter
kidneys, M. Ca
of potash by m
fuse diuresis, th
every night.
relates a case
case of typhus
convalescent on

Dr. Young
incontinence of
bladder or its s

In sore-thro
mixture of nitr
diminishing the

Nitre is rar
producing cold.
sal ammoniac,
40° F.; that is

---

[1] *London Med*
[2] *Lancet*, Feb.
[3] *Gazette des*
[4] *L'Union Mé*

fore, we sometimes employ this mixture, placed in a bladder, as an external application. On the belief that fever, cholera, and other malignant diseases, were produced by a deranged state of the blood, and that this derangement depended on, or consisted in, a diminution or entire loss of the saline parts of the blood, Dr. Stevens employed nitre, chloride of sodium, and other alkaline salts, in the treatment of these diseases.[1] I have already (see *ante*, p. 185) had occasion to refer to this subject. Nitre, in large doses, has been employed in the treatment of scurvy, and with considerable success, according to the statement of Mr. Cameron.[2] This accords with Dr. Garrod's views, already explained. [Some experiments have more recently been made on the relative value of nitrate of potash, citric acid, and lime-juice, as remedial agents in sea-scurvy; and the results have not been favourable to the use of nitrate of potash. Dr. Bryson has published an account of these experiments,[3] which were instituted upon the instructions of the Director-General of the Medical Department of the Navy to the surgeons of convict-ships. These were to the effect, that in the event of scurvy making its appearance during the voyage, they were to try the relative merits of the three remedies. The patients were to be divided into three sets, each set as nearly as possible resembling another in all circumstances, except that to one was to be given lime-juice, to a second, citric acid; to a third, nitrate of potash. The effects were carefully noted. The results are thus stated by Dr. Bryson: "There seems to be little reason to doubt, judging from the results in these trials, and from others which were not so well conducted, that the alkaline salt (nitre) has not the antiscorbutic properties which have been ascribed to it; while, from its nauseous, mawkish taste, and injurious effects on the system generally, unless in very minute doses, it would be worse than cruelty, under any circumstances, to persist in its exhibition in this disease, either as a prophylactic, or as a means of cure."—ED.]

ADMINISTRATION.—Nitrate of potash may be given in doses of from ten grains to half a drachm, in the form of powder, mixed with sugar, or in solution. If administered as a refrigerant, it should be dissolved in water and immediately swallowed, in order that the coldness of the solution may assist the action of the salt. If employed as a diuretic, we ought to give mild liquids plentifully, and keep the skin cool.

ANTIDOTE.—No chemical antidote for this salt is known. In case of poisoning, therefore, we should remove the poison from the stomach as speedily as possible, and administer tepid emollient drinks. Opiates, perhaps, may be advantageously administered. The inflammatory symptoms are to be combated by the usual antiphlogistic measures.

INHALATIO NITROSA; *Fumigatio Nitrosa*.—The fumes produced by the deflagration of nitrate of potash with paper have been inhaled with benefit in spasmodic asthma.[4] To obtain them, blotting paper is to be dipped in a saturated solution of nitre, and afterwards dried: by this means we obtain what is commonly called *touch paper*. The fumes evolved by its ignition are to be inhaled either by setting fire to the paper on a plate, or rolled up and placed in a candlestick, and letting the fumes escape into the room, the

---

[1] Stevens, *op. supra cit.* pp. 296, 298, &c.

[2] *Medico-Chirur. Review*, March 1830, p. 484.

[3] *Medical Times*, vol. xxi. p. 212.

[4] *London Medical Gazette*, Sept. 4, 1846, p. 431.

air of which soo
the paper in a
experiences thei

54. POTA

Fo

HISTORY.—It
Lully in the thir
such as *terra fo*
tartar (*tartar*

NATURAL HIS
It exists in the j
Winter's bark,
contain it.

PREPARATION.
of this salt.

The *London Colle*
Water, f℥xij. Add
tion, then strain.
until the salt is drie

The *Edinburgh C*
℥vij., or a sufficienc
is accomplished. E
as to form a concret
which must be brok

The *Dublin Colleg*
Carbonate of Potash
placed in a porcelain
cence has ceased, bo
same acetic acid, so
rated to dryness, me
cast iron. The lique
it has solidified, it s
in a bottle furnished

In this process
engages carbonic

To obtain a per
prevent the salt fr
solution, a slight

PROPERTIES.—
foliated texture (
having a pungent
and, therefore, oug
soluble both in w
soluble salts we a
dissolve in 102 pa

Characteristic
base. As an acet

---

to be stated. Its deliquescence is also a characteristic. [A current of carbonic acid precipitates the potash as carbonate, from a strong alcoholic solution of this salt.—ED.]

COMPOSITION.—Its composition is as follows:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Wenzel.*	*Richter.*
Potash	1	47	47·96	50·15	51·4
Acetic acid (dry)	1	51	52·04	49·85	48·6
Acetate of Potash	1	98	100·00	100·00	100·0

IMPURITY.—It should be white and perfectly neutral. Frequently, however, it reacts on test-paper as an alkali, owing to a slight excess of potash. The presence of chlorides may be detected by nitrate of silver; of sulphates, by chloride of barium; of metals, by hydrosulphuric acid or ferrocyanide of potassium.

[The characters of this salt are as follows:—

A colourless pulverulent salt; it is nearly inodorous, and has a pungent saline taste; it is extremely deliquescent, very soluble in water and in alcohol, which latter solution is decomposed by a current of carbonic acid gas; it is decomposed by heat and converted into carbonate of potash. As usually prepared it has a foliated appearance, which is given to it by fusion, and cooling: in this operation, however, unless very carefully conducted, and by some one acquainted with the mode of performing it, the acetate is liable to be decomposed; in this fused state it is vulgarly termed "foliated tartar."

Soluble in rectified spirit and in water. The aqueous solution does not change the colour of litmus or of turmeric. Chloride of barium or nitrate of silver produces no precipitate in this solution. If any precipitate should be caused by nitrate of silver in a saturated solution, this is redissolved by the addition of water or of diluted nitric acid. Sulphuric acid evolves from it the odour of acetic acid. From 100 grains of this salt digested in sulphuric acid, there should be obtained, after evaporation and ignition, a residue of 88·8 grains of sulphate of potash.—*Ph. Lond.*]

PHYSIOLOGICAL EFFECTS.—Two or three drachms cause purging, which is sometimes accompanied with griping. In smaller doses, more especially if largely diluted, it acts as a diuretic and mild diaphoretic. In its passage to the kidneys it becomes decomposed, and is converted into the carbonate of potash (see *ante*, p. 184), which may be detected in the urine. Probably the pulmonary excretions of those who employ it also become impregnated with this salt, since it has been said that in persons with delicate lungs it acts as an irritant to these organs.

USES.—In this country it was until lately rarely employed, except as a diuretic in dropsical complaints. It is a valuable adjunct to other renal excitants. On the continent it is administered in various diseases as an alterative or resolvent. Thus, in scirrhus of the pylorus, chlorosis, and visceral and glandular enlargements. It may be employed in the lithic acid diathesis, to render the urine alkaline. It is of course improper when phosphatic deposits are observed in the urine.

[Acetate of potash has been usefully employed in some diseases of the skin. Dr. Easton, of Glasgow, has related a series of cases of psoriasis, eczema, and lepra, in which he has found the administration of acetate of potash attended with signal benefit.[1] The cure was much more speedy than under the use of any other remedies. The salt was administered alone, and was followed by a great

---

[1] *Edinburgh Monthly Journal*, May 1850.

increase in the
54 oz. in the tw
of this salt, it
but that the p
believes that t
lation, and tha
Mr. Hilton
in gonorrhœa.
alkalising effec
has also been
hours by sever
ficial influence
ADMINISTRA
drachm and a
or three drachn

55. POTAS

Two compou

1. The ne
2. The ac

Both of these

1. Potassæ

Form

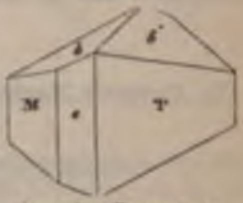
HISTORY.—T
tartar (*tartar*
tartarised kali
It is the *tartrat*
PREPARATION.
ration of this sal

The *Edinburgh C*
Potash, ℥xvj., or a
bonate of potash in
neutralised, boil an
The process of th
from Pearlash, ℥viij
quantity; Distilled
to the solution, wh
ebullition has been
or reddened litmus.
pellicle forms on its
liquid, and having d
bottle.
The London Coll
paring it is given.

In this process the excess of acid in the bitartrate is saturated by the potash of the carbonate: the carbonic acid escapes. Or if we assume tartaric acid to be a bibasic acid, cream of tartar is to be regarded as a monobasic tartrate of potash, and on the addition of another atom of acid it becomes a bibasic tartrate.

PROPERTIES.—It is usually met with in the shops in a granular state; but it ought to be crystallised. Its crystals are right rhombic prisms. To the taste this salt is saline, and somewhat bitter. It deliquesces when exposed to the air, and is soluble in its own weight of water at 50°: the solution is decomposed by keeping.

FIG. 89.



Crystal of Tartrate of Potash.

Characteristics.—Its characteristics are those of a potash salt and of a tartrate (see *Acidum Tartaricum*). When heated to redness it is decomposed, leaving as a residue charcoal and carbonate of potash. When heated, the salt evolves the odour of caramel. If a small quantity of a strong acid (as the sulphuric) be added to a strong solution of this salt, we obtain crystals of the bitartrate; sulphate of potash being at the same time formed. Hence acids, and most acidulous salts, are incompatible with it, as also are tamarinds. The tartrate is readily distinguished from the bitartrate by its deliquescent property, its greater solubility, and its want of acidity. [Chloride of calcium precipitates a solution of the tartrate, but not of the bitartrate of potash.—ED.]

COMPOSITION.—The following is the composition of this salt:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Berzelius.*
Potash	2	94	41·593	41·31
Tartaric acid	1	132	58·407	58·69
Neutral Tartrate of Potash	1	226	100·000	100·00

The large crystals contain, according to Dr. Thomson,[1] four equivalents of water, $2KO,\bar{T},4HO$. The same authority states that he has had crystals of this salt in needles which seemed to contain no water of crystallization.

IMPURITY.—It may contain excess of acid or of base, either of which is easily recognised;—the one by litmus, the other by turmeric. The sulphates may be detected by chloride of barium throwing down a white precipitate insoluble in nitric acid.

It is soluble in water. The aqueous solution does not change the colour of litmus or of turmeric. When any acid is added to the (strong) solution, bitartrate of potash is thrown down in crystals, which for the most part adhere to the sides of the vessel. What is thrown down from this solution by chloride of barium or acetate of lead, is dissolved by diluted nitric acid.—*Ph. Lond.*

PHYSIOLOGICAL EFFECTS.—This salt is a gentle purgative and diuretic. Like the other vegetable salts of the alkalies, it is decomposed in the system, and converted into the carbonate (see *ante*, p. 184), in which state it is found in the urine, to which it communicates alkaline properties. It is said to have the power of preventing the griping of other more active cathartics, as senna and scammony; but, from my own personal observations, I doubt the correctness of this statement.

---

[1] *First Principles of Chemistry*, vol. ii. p. 264.

USES.—It i
ment of diarr
adjunct to oth
used in lithiasi
the form of a
for destroying
ADMINISTRA
drachms to hal

2. Potassæ

Form

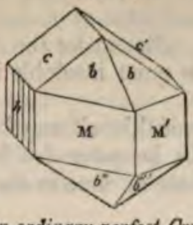
HISTORY.—
known at a
" because it pro
hell does." S
various names o
or *acidulous ta*
NATURAL HI
of grape juice, f
It is more abun
other vegetables,
PRODUCTION.
vinous fermentat
soluble in a mixt
(that is, when su
of the cask. In
tartar (*tartaru*
tarus albus vel
wine. *Argol*, or
and is composed
biracemate of po

At Montpellie
the solution allo
are washed with
coal and alumina
colouring matter
to cool slowly, b
depuratus or *cr*
solution of tarta
layer of very fine
tartar (*cremor t*
PROPERTIES.—
mass, without od

---

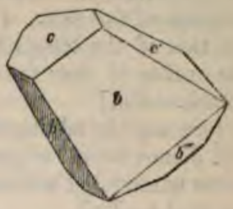
to Mr. Brooke,[1] its crystals are right rhombic prisms (figs. 90 and 91). Liebig,[2] however, says they are oblique rhombic prisms. It is unaltered by exposure to the air; but when heated, it decomposes, swells up, evolves various volatile products, gives out an odour of caramel, and is converted into *black flux* (*fluor niger*), — a compound of charcoal and carbonate of potash. If made with raw tartar containing nitrogen, the black flux will be contaminated with bicyanide of potassium. If the acid tartrate be deflagrated with nitrate of potash, the residue is *white flux* (*fluor albus*), or carbonate of potash. Bitartrate of potash is very slightly soluble in water, and is insoluble in alcohol.

FIG. 90.



An ordinary perfect Crystal of Bitartrate of Potash.

FIG. 91.



Common Crystal of ditto.

Characteristics.—One character of this salt is derived from the phenomena attending its conversion into black flux, as above mentioned. If black flux be digested in water, we obtain a solution of carbonate of potash, the characteristics of which have been already stated. Another character of the bitartrate is its slight solubility in water, and its solution reddening litmus. The addition of caustic potash increases its solubility, whereas alcohol diminishes it. Acetate of lead added to a solution of the bitartrate forms a copious white precipitate: lime water has the same effect; [but the tartrate of lime is dissolved by an excess of the bitartrate.—ED.] Mixed with alkaline carbonates, it produces effervescence. [The saturated aqueous solution gives no precipitate with chloride of platina. Potash can only be detected by this test after the conversion of the salt to carbonate by incineration. It is not precipitated by acids like a solution of the tartrate, and it is only sparingly precipitated by nitrate of silver, while the tartrate is copiously precipitated. Bitartrate of potash may be produced directly by projecting a fragment of potassium on a strong solution of tartaric acid.—ED.]

COMPOSITION.—Crystallised acid tartrate (bitartrate) of potash has the following composition:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Berzelius.*
Potash	1	47	25·00	24·80
Tartaric acid	1	132	70·21	70·45
Water	1	9	4·79	4·75
Crystallised Acid Tartrate of Potash	1	188	100·00	100·00

IMPURITY.—Acid tartrate of potash when pure is quite white. As found in commerce it usually contains from 2 to 5 per cent. of tartrate of lime; and hence a little carbonate of lime may be detected in black flux. This is of no material consequence in a medicinal point of view. To detect the tartrate of lime, digest the suspected acid tartrate of potash with a solution of caustic ammonia, and test the filtered solution with oxalate of ammonia. If the powdered acid tartrate be adulterated with either alum or bisulphate of potash,

---

[1] *Annals of Philosophy*, new series, vol. vii. p. 161.
[2] Turner's *Chemistry*, 7th edit.

the fraud may be
cipitate (*sulphat*
and solution of
solution of this s
solution of the b
the oxalate of lin
potash.—Ed.]

[Among the a
Mr. James Grant
tartar adulterated
per cent.[1]—Ed].

To detect race
of potash with pu
sal ammoniac. I
cipitate caused by

It is sparingly dis
it is converted into
"Entirely soluble
with 30 grains of cr
of nitrate of lead, th

Physiological
water, it acts as a
drachms) it purge
tinued use it dis
probably from def
tion of the stomac
Tyson.[2] A man,
table-spoonfuls of
and other sympton
and legs appeared
examination, the s
which the bitartrat
effects on the urin

Uses.—Acid o
refrigerant drink
diminishes pretern
in dropsical compl
form of an electu
in general, with j
dropsical complain
and bitartrate of
piles, stricture, and
of sulphur, bitartra
aperient may be pr
and a half drachn
tartrate of soda.

---

on account of its gritty qualities: a very good dentifrice consists of equal parts of bitartrate, powdered rhatany root, and myrrh.

ADMINISTRATION.—As a hydragogue cathartic, the dose is from four to eight drachms; as an aperient, one or two drachms; as a diuretic, in repeated doses of a scruple to a drachm (see *Pulvis Jalapæ Compositus*).

1. **POTUS IMPERIALIS**; *Tisana Imperialis; Imperial.*—It is formed by dissolving one drachm or a drachm and a half of cream of tartar in a pint of boiling water, and flavouring with lemon-peel and sugar. When cold, the solution may be taken *ad libitum*, as a refrigerant drink in febrile complaints, and as a diuretic.

2. **SERUM LACTIS TARTARIZATUM**; *Cream of Tartar Whey.*—This is prepared by adding about two drachms of the bitartrate to a pint of milk. It may be diluted with water, and taken in febrile and dropsical complaints.

56. Potassæ Boro-tartras.—Boro-tartrate of Potash.

The addition of either boracic acid or borax to cream of tartar greatly increases the solubility of the latter; and the compound produced has been termed *soluble cream of tartar* (*cremor tartari solubilis*). It was discovered by Le Fèvre in 1732.

In the French Codex, the *tartras borico-potassicus* is prepared by dissolving 40 parts of bitartrate of potash and 10 parts of crystallised boracic acid in 240 parts of water, and evaporating the solution either to dryness or to a syrupy consistence, and then spreading it on plates to dry. The compound thus obtained is white, has a sour taste, is incapable of crystallising, and is soluble in water in all proportions. According to Soubeiran, soluble cream of tartar, when chemically pure and saturated with boracic acid, consists of $KO,2\bar{T}+BO^3$ or $KO,\bar{T}+BO^3\bar{T}$.

In the Prussian Pharmacopœia, *tartarus boraxatus* is prepared by dissolving one part of borax in ten parts of boiling water, and then adding three parts of depurated tartar deprived of tartrate of lime. The solution is to be evaporated by a gentle heat, in a vapour bath, until it becomes a tenacious mass; it is then to be placed on paper, dried by a gentle heat, and rubbed to powder. It is a white deliquescent powder, having an acid taste, and being soluble in its own weight of water. According to Duflos, it consists of $KO,NaO,2\bar{T}+2(KO,BO^3,2\bar{T})+3HO$.

USES.—Boro-tartrate of potash partakes of the medicinal properties of cream of tartar and borax. Its great solubility gives it an advantage over cream of tartar. In doses of from half an ounce to an ounce it acts as a cooling purgative. In smaller doses it is diuretic, and is said to be emmenagogue. It has been employed in dropsical affections, amenorrhœa, hepatic congestion, and various other maladies. As a resolvent, it is given in doses of a scruple. It has been recommended by Mr. Ure[1] as a solvent for lithic acid calculi.

57. Potassæ Citras.—Citrate of Potash.

Formula $3KO,C^{12}H^5O^{11}$; or $3KO,\bar{Ci}$. *Equivalent Weight* 306.

Neutral Citrate of Potash; Sal Absinthii citratum; Tribasic Citrate of Potash.—Prepared by saturating a solution of crystallised citric acid with bicarbonate of potash, and evaporating to dryness.—If lemon-juice be substituted for the solution of citric acid, the resulting compound will contain, besides some mucilaginous and extractive matter, a portion of malate of potash (*kali malico-citratum*). If commercial carbonate of potash be substituted for the bicarbonate, some hydrate of silica separates when the carbonate is saturated with citric acid. Neutral citrate of potash is a deliquescent solid, and, there-

---

[1] *Pharmaceutical Journal*, vol. i. p. 191.

fore, requires t
groups of acicula
to Heldt, contai
Citrate of pot
medicinal effects
promotes. It is
a hot and dry sk
potash. When
opiate. It is pe
salts of the alka
The dose of the
if desired, with s
1. Liquor Po
Mixture.)—Take
quantity. Add
saturated; then
minims; Water,
Acid with the Oil
add the Carbonat
The dose of thi
about an equal m
2. Liquor Pot
—This constitute
potion (potio Rive
state of effervesce
or lemon-juice.
uniform strength.
℞ Potassæ Bic
Aquæ distillatæ, ℥
sufficit, in actu eff
Instead of lemo
of water, may be
lemons. This dra
in addition to thos
remedy for allayin
grateful, for the
very rebellious, tw
added to the draug
times advisable to
the draught, and to
The preparation

58.

Three compounds
1. **Potassæ Mo**
by saturating a solu
its formula is KO,C
2. **Potassæ Bin**
Oxalis Acetosella an
Spinacia oleracea, *A*
is obtained by satur
then adding a secon
and Switzerland, it i
evaporating the exp
the plant yield four
or *sal acetosellæ*.
merce. It crystalli
or, according to Gra
this salt, one is exp

alkaline carbonate is just sufficient to neutralise the redundant acid of the other portion (Wollaston).

The oxalic acid contained in the binoxalate appears to pass through the system unchanged (see *ante*, p. 174), and reappears in the urine in the form of oxalate of lime. Hence, when crystals of the latter salt are desired for microscopic examination, they may be obtained by the employment of rhubarb tart or sorrel sauce at table. Those persons, however, who labour under the oxalic diathesis should carefully avoid the use of all such articles of food.

3. **Potassæ Quadroxalas**; *Quadroxalate of Potash.*—This salt is made by neutralising a solution of one part of oxalic acid with carbonate of potash, and then adding three parts more of acid. It is sold in commerce under the name of *sal acetosellæ*, or *salt of sorrel*; and, from a mistaken notion that it is identical with the real salt of wood-sorrel, it is frequently termed *binoxalate of potash*. The *sel d'oseille* of French commerce is stated by Berard to be this salt; but Soubeiran says it is sometimes the binoxalate—sometimes the quadroxalate.

Quadroxalate of potash crystallises in colourless transparent prisms of the doubly-oblique prismatic system; and which consist of $KO,4C^2O^3,7HO$, or, according to Graham, of $KO,C^2O^3+HO,C^2O^3+2(HO,C^2O^3+HO)$. If three parts of the salt be converted into carbonate by heat, and added to a solution of one part, the neutral oxalate of potash is formed (Wollaston). The commercial quadroxalate (salt of sorrel) is not pure; for I find that it yields, by ignition in a covered crucible, carbonate of potash contaminated with carbonaceous matter; whereas the pure quadroxalate yields the carbonate only.

It is employed for removing ink stains and iron moulds from linen, and for decolorising straw used for bonnet-making. This salt was formerly used in medicine as a refrigerant. In France, *tablettes ou pastilles à la soif* are prepared with it. It possesses poisonous properties similar to, but less energetic than, oxalic acid. A case of poisoning by about an ounce of this salt has been published by my friend and former pupil, Mr. John Jackson.[1] The accident was not known for an hour and a half after it occurred. The symptoms were those of great depression of the heart's action, but without either tetanus or coma. The eyes were sore, the vision dim, the conjunctivæ a good deal affected, and the pupils dilated. The patient ultimately recovered. Half an ounce of salt of sorrel, taken by a lady in mistake for cream of tartar, caused death in eight minutes.[2] The treatment of poisoning by this salt is the same as for oxalic acid (see *Acidum Oxalicum*).

Under the name of *salt of lemons* (*sal limonum*) is usually sold a mixture of two parts quadroxalate of potash (salt of sorrel) and one part cream of tartar. Sometimes, however, the quadroxalate alone is sold under this name.

ORDER XII. COMPOUNDS OF SODIUM.

Sodium or *natrium* ($Na=23$), the metallic basis of the alkali soda, has not hitherto been employed in medicine. It will not, therefore, require further notice.

59. Soda.—Soda.

Formula NaO. *Equivalent Weight* 31.

Fossil or Mineral Alkali; Caustic Soda; Oxide of Natrium.—First accurately distinguished from potash by Du Hamel in 1736. In combination it is found in the mineral kingdom, in plants (especially those which grow in, or on the borders of, the sea), and in many animal fluids. In the anhydrous state it is obtained by the oxidation of sodium. In its general properties it agrees very much with potash, than which it is less caustic. Its

---

[1] *London Medical Gazette*, Dec. 18, 1840. In the same journal for March 5th, 1841, is a case of poisoning by about two scruples of oxalic acid swallowed in combination with carbonate of soda (*superoxalate of soda?*).

[2] *Ann. d'Hyg.* Avril 1842: quoted by Dr. A. S. Taylor.

solution, if pure,
phates, or carbon
pitate with perch
bichloride of plat
alcohol. The onl
solutions of soda
timoniate of soda.
mentioned be pres
and nitrate) is res
1. Liquor Sod
Obtained from car
carbonate of potas
2. Liquor Sod
of Soda, ℥xxxj.; I
the same manner b
is 1·061. Four gr
what has been bef
the last characteris
Take of Crystall
Distilled Water, *C*
Carbonate of Soda
boiling point in a c
the ebullition for t
fire, and when, by
become perfectly cl
with an air-tight st
3. Sodæ Hydra
of potash is procu
officinal.

60. SODÆ

Soda and carb
form three distin

1. Monocar
2. Sesquicar
3. Bicarbon

The sesquicarb

1. Sodæ Mono

History.— Bot
known to the anc
The *salt alkali,*
word *sagimen* is
times this salt has
alkali, aërated m

---

[1] [A solution of pur
of oxide of lead, and gi
[2] *Invention of Verit*
[3] Dr. Royle, *Essay*

and now usually *carbonate of soda* (*sodæ carbonas*, Ph. L.; *sodæ carbonas crystallizatum*, D.)

NATURAL HISTORY.—This salt is peculiar to the inorganised kingdom.

It is found in crystals, or in the form of an efflorescence, in several parts of the world; as in Egypt, Hungary, Bohemia, &c. The following are the results of various analyses of it:—

COMPOSITION OF NATRON.

	Egyptian.		*Hungarian.*			*Vezuvian.*	*Barbary.*	*Bohemian.*
			Border of Lac Blanc.	Commercial of Debreczin.			In small layers in common salt.	
	(Klaproth.)[1]	(Beudant.)[2]	Beudant.	(Beudant.)	(Lampadius.)[3]	(Beudant.)	(Beudant.)	(Reuss.)[4]
Soda.....	32·6	43·8	50·2	42·2	14·2	46·7	43·6	89·18
Carbonic Acid		30·9	35·1	30·4		33·3	35·5	
Sulph. Soda (dry)	20·8	7·3	*traces*	10·4	9·2	*traces*	..	
Common Salt	15·0	3·1	..	2·2	22·4	2·7	..	..
Earthy matters	..	1·4	..	..	9·2	5·3	4·2	CaO,CO² 7·44 MgO,CO² 1·35
Water	31·6	13·5	14·7	13·8	45·0	14·0	16·7	Extractive 2·03
	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·00

From these analyses it appears that the native monocarbonate of soda contains only one atom of water of crystallisation. NaO,CO^2,HO.

It frequently occurs as an efflorescence on walls, sometimes in combination with sulphate of soda, and is probably derived from the soda salts contained in the limestone used for making mortar, or from the soda contained in the coals employed in burning the lime, or from the bricks or stones used as the building material.[5] Carbonate of soda is a constituent of some mineral waters, which are, in consequence, termed *alkaline*, or, when they also contain a large excess of carbonic acid, *acidulo-alkaline*.

PRODUCTION.—The commercial sources of carbonate of potash are three—viz. native soda, the ashes of marine plants, and common salt or sulphate of soda.

1. *Native carbonate of soda.*—Egyptian natron is employed in the arts as carbonate of soda; but it appears to be sometimes mixed or combined with sesquicarbonate or bicarbonate (see *Sodæ Sesquicarbonas*). The Hungarian native carbonate of soda, called *székső*, exudes as an efflorescent crust upon the surface of the ground. It occurs near Mariatheresiopel, in the department of Bichar, and also in Lesser Cumania, near Szegedin, where there are five manufactories engaged in its production. The soda-earth is lixiviated, the solution evaporated to dryness, and the saline residue heated to redness to destroy the extractive matters. The carbonate of soda which is obtained is contaminated with sulphate of soda, chloride of sodium, and earthy impurities.[6]

2. *Ashes of marine plants.*—These are of two kinds—one, called *barilla*, obtained from phenogamous plants growing near the sea; the other, termed *kelp*, procured from cryptogamic plants growing in the sea.

a. **Preparation of Barilla.**—The substance called *barilla* (*sodæ carbonas venale*) is an ash usually obtained by the combustion of plants belonging to the order Chenopodiaceæ; as the species of Salsola, Salicornia, and Chenopodium. These are cultivated on the coasts, and when ripe are cut, dried, and burned in heaps: the resulting ash is barilla. It is a hard greyish or bluish mass, not deliquescent, having an alkaline acrid taste, and a peculiar odour. It consists of *carbonate* and *sulphate of soda, sulphuret* and *chloride of sodium, carbonate of lime, alumina, silica, oxide of iron,* and *carbonaceous matter* which has escaped combustion. The carbonate of soda is produced by the decomposition of the organic salts of soda contained in the plants before combustion. Several varieties of barilla are known in the market: they are distinguished by the names of the places from whence they are imported—namely, the Grand Canary and Teneriffe Islands, Alicant, Sicily, Carthagena, and the East Indies.

---

[1] *Beiträge*, Bd. iii. p. 80, 1802.

[2] *Traité élémentaire de Minéralogie*, 2me édit. tom. ii. p. 310, 1832.

[3] Quoted by Jameson, *System of Mineralogy*, 2d edit. vol. ii. p. 312, 1816.

[4] Quoted by Jameson, *ibid.*

[5] [It probably arises from a reaction of common salt contained in the mortar on the carbonate of lime. The efflorescence generally appears when dry weather follows wet. The silky efflorescence found on the mortar of damp cellars is chiefly sulphate of soda.—ED.]

[6] Knapp's *Chemical Technology*.

Canary barilla is procured from Salsola kali.[1]

Alicant barilla (*soda hispanica*; *soda alicantina*) is obtained from Salsola sativa, Chenopodium setigerum, and other species.[2] It yields from 25 to 40 per cent. of carbonate of soda.

Sicily barilla is procured principally from Salsola sativa: it furnishes, according to Fée,[3] 55 per cent. of carbonate of soda.

Of the *French barillas* two only deserve notice—namely, that of Narbonne, called *salicor*, and obtained from Salicornia herbacea, and which yields 14 or 15 per cent. of carbonate; and that of Aiguemortes, called *blanquette*, obtained from species of Salicornia, Salsola, and Atriplex, and which contains from 3 to 8 per cent. only of alkaline carbonate.

The importation of barilla has very much fallen off of late years, in consequence of the production of carbonate of soda from sulphate of soda. In 1827, the quantity imported was 326,239 cwts.;[4] whereas, in 1840, it was only 284 tons.[5]

β. **Preparation of Kelp.**—Kelp (called by the French *varec*, or *Normandy soda*) is procured by the combustion of cryptogamic plants of the order Algaceæ. According to Dr. Greville,[6] the species most valued for this purpose are Fucus vesiculosus, nodosus and serratus, Laminaria digitata and bulbosa, Himanthalia lorea, and Chorda Filum. These are dried, and then burned in coffers of stone or in kilns. About 24 tons of sea-weed are required to produce one ton of kelp.[7] The resulting ash is kelp. As met with in commerce, it consists of hard, dark grey or bluish masses, which have an acrid, caustic taste, and are composed of *chloride of sodium*, about five per cent. of *carbonate of soda* (formed by the decomposition of the organic salts of soda), *sulphates of soda* and *potash, chloride of potassium, iodide of potassium* or *sodium*, and *insoluble* and *colouring matters*. By digesting kelp in a small quantity of water, and filtering and evaporating the solution, crystals of carbonate of soda may be procured. But as this salt can be procured at a lower price and of finer quality from artificial soda, kelp is now of little value as a source of soda. In the Orkney Islands, about 20,000 persons were, a few years since, occupied in the manufacture of it.[1]

---

[1] Loudon, *Encyclopædia of Agriculture.*

[2] Lagasca, quoted in De Candolle's *Phys. Vég.* p. 388.

[3] *Cours d'Hist. Nat.* t. ii. p. 488.

[4] *A General Statement of the Imports and Exports*, printed by order of the House of Commons, February 24th, 1829.

[5] *Trade List*, January 5th, 1841.

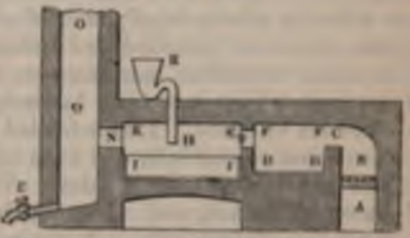
[6] *Algæ Britannicæ*, p. 21.

[7] Macculloch, *Western Islands*, vol. i. p. 123.

3. *Artificial soda.*—This is obtained from sulphate of soda, or indirectly from common salt. The principal manufactories are situated in the northern parts of the kingdom, and are conducted on a most extensive scale. The process adopted varies in some of its details in different places; but it consists essentially in the conversion of common salt (chloride of sodium) into sulphate of soda, and the decomposition and conversion of this into carbonate of soda.

The sulphate of soda employed is in part obtained from manufacturers of chloride of lime, who procure a considerable quantity in the process for generating chlorine: but the greater part of it is made expressly by adding sulphuric acid to common salt (chloride of sodium). $NaCl + HO,SO^3 = NaO,SO^3 + HCl$. The hydrochloric acid gas evolved in this process is highly injurious to vegetable and animal life[2] (see *ante*, p. 388); and various contrivances have been resorted to to prevent its escape into the atmosphere, as by absorbing it by water or lime. The sulphate of soda, reduced to powder, is usually decomposed by mixing it with an equal weight of ground chalk (carbonate of lime) and half its weight of small coal ground and sifted, and heating the mixture in a very hot reverberatory furnace. During the operation it is frequently stirred. The product has a dark grey or blackish appearance, and is called *crude soda*, *British barilla*, *ball alkali*, or *black balls*. It consists essentially of carbonate of soda, caustic soda, and oxisulphuret of calcium.

FIG. 92.



Furnace for converting Chloride of Sodium into Sulphate of Soda.

A. Ash-pit.
B. Grate.
C. Bridge.
D, D. First calcining hearth.
F, F. Its roof.
G. Second bridge.
I, I. Square lead pan.
K, K. Roof of decomposing hearth.
N. Third bridge.
O, O. Chimney filled with round flint nodules, kept continually moist by the trickling of a streamlet of water upon the topmost layer. The muriatic acid is absorbed by the water, and the solution escapes below at E.
R. Syphon funnel, by which the sulphuric acid is introduced.

In this process two consecutive changes occur: in the first place, the carbon of the coal deoxidises the sulphate of soda, the products being carbonic oxide and sulphuret of sodium. $NaO,SO^3 + 4C = NaS + 4CO$. In the second place, the sulphuret of sodium and carbonate of lime interchange their constituents, and give rise to carbonate of soda and sulphuret of calcium. $NaS + CaO,CO^2 = NaO,CO^2 + CaS$. But as a portion of the carbonate of lime has been burned or deprived of its carbonic acid before this interchange occurs, some caustic soda is also produced. $NaS + CaO = NaO + CaS$. To prevent, in the subsequent operation of lixiviation, the decomposition of the carbonate of soda by the sulphuret of calcium, twice as much carbonate of lime is used as is necessary to desulphurise the sulphuret of sodium: this

---

[1] Greville, *op. cit.*

[2] A very humorous account of the unpleasant effects of this gas is contained in the report of a trial at Lancaster, March 31, 1838, the Queen *v.* Airey, in the *Times* newspaper.

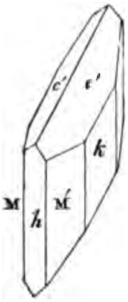
excess of carbon
the resulting lim
sulphuret of ca
phuret of sodium
of the Newcast
of soda 9·89, *hy*
of lime 15·67, *s*
of iron 1·22,
water 2·17.

Ball alkali is
water, and the c
more difficultly s
deposits crystals
yields a dark cr
sulphuret of sod
the oxidation of
of the sulphur (
calcined with co
sulphuret of so
caustic soda com
or *soda salts*,
crystallised carb
straining the solu
iron pans.

PURIFICATION.
tained pure by re
traces of sulphate

PROPERTIES.—
oblique rhombic

FIG. 93.



Ordinary Crystal.

with bichloride of
cipitate with it.
described.

---

[1] For further details
Brande, *Manual of Ch*
Knapp's *Chemical Tec*

COMPOSITION.—The perfect crystals of the ordinary carbonate of soda of commerce have the following composition .—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Klaproth.*	*Kirwan.*	*Bergman.*
Soda	1	31	21·68	22	21·58	20
Carbonic acid	1	22	15·39	16	14·42	16
Water	10	90	62·93	62	64·00	64
Crystallised Carbonate of Soda	1	143	100·00	100	100·00	100

Four other crystallised monocarbonates of soda have been described: they contain respectively HO, 5HO, 6HO, and 8HO (L. Gmelin).

IMPURITY.—The ordinary impurities of this salt are sulphates and chlorides. These are detected as follows:—Supersaturate with nitric acid, and then add, to separate portions of the diluted solution, chloride of barium and nitrate of silver: if the first occasion a white precipitate, it indicates the presence of a sulphate—if the second also produce a white precipitate, insoluble in nitric acid, it shows the presence of a chloride. The presence of hyposulphite of soda is detected by hydrochloric acid, which causes the evolution of sulphurous acid gas, and the precipitation of sulphur, [or by the addition of a strong solution of nitrate of silver. If hyposulphite of soda be present, a white precipitate, becoming rapidly yellow and brownish black (sulphuret of silver), is produced.—ED.] Carbonate of lime, and also carbonate of magnesia, are sometimes kept in solution by carbonate of soda. If carbonate of lime be present, the solution deposits, at 32° F., a white crystalline powder, the hydrochloric solution of which yields a white precipitate with oxalate of ammonia.

Free from colour, transparent; exposed to air it soon falls to powder. It is dissolved by water. This solution changes the colour of turmeric brown. When saturated by hydrochloric acid, chloride of barium precipitates nothing from it. One hundred grains lose 62·5 grains of water at a strong heat. An equal quantity added to dilute sulphuric acid loses 15·28 grains of carbonic acid.—*Ph. L.*

"A solution of 21 grains in a fluidounce of distilled water, precipitated by 19 grains of nitrate of baryta, remains precipitable by more of the test; and the precipitate is entirely soluble in nitric acid. Little subject to adulteration."—*Ph. Ed.*

PHYSIOLOGICAL EFFECTS.—Carbonate of soda is less acrid and caustic, and has a milder and less unpleasant taste, than carbonate of potash; but in other respects the effects of these two salts on both vegetables and animals are similar.

USES.—Carbonate of soda is used in the same cases as carbonate of potash, over which it has the advantage of a less disagreeable taste. Fourcroy imagined that as soda is contained in animals in larger proportion than potash, it was a better agent for medicinal use. Experience, however, has not confirmed this opinion, but has proved the reverse; for both Sir G. Blane[1] and Mr. Brande[2] state that they obtained beneficial effects, in calculous complaints, from the use of potash, where soda failed to give any relief. Sir G. Blane accounted for this by assuming that soda becomes applied to the purposes of the economy before it reaches the kidneys, whereas potash is carried to these organs in order to be thrown out of the system. [A case of sudden death following the long-continued use of carbonate of soda is recorded by Dr. Tunstall, of Bath. The man suddenly fell dead while

---

[1] *Transactions of a Society for Improving Medical and Chirurgical Knowledge*, vol. iii. p. 347.

[2] *Quarterly Journal of Science*, vol. vi. p. 205.

walking in the
and the post-m
by fatal synco
the long-conti
sixteen years to
the stomach wa
ulcerations var

ADMINISTRA
from ten grains
the manufactur

20 grs. of Crystall
saturated by ab

ANTIDOTES.—

SODÆ CARBO
Dried Carbon
carbonate of so
afterwards heat
tallised Carbona
in a porcelain ca
forms is convert
enclose it in a b
tially the same)
hundred and fo
exhibited either

It is soluble in w
ought to evolve 40

2. Sodæ

HISTORY.—Th
soda in 1802 by

NATURAL HIS
probably formed,
salt and carbonat

1. In the pro
Fezzan, there is f
by the Africans *t*
and *natron* are d
which are rarely
fort now in ruin

---

[1] *Medical Ti*
[2] *Beiträge*, B
[3] Berthollet,
[4] Bagge, quot

analysed by Klaproth, Beudant,[1] and Mr. R. Phillips,[2] and found to be a sesquicarbonate of soda.

2. At the bottom of a lake at Lagunillas, near Merida, in Venezuela, is found a substance, called by the Indians *urao*. It is collected every two years by the natives, who, aided by a pole, plunge into the lake, separate the bed of earth which covers the mineral, break the urao, and rise with it to the surface of the water. It is placed in boats, removed to the magazine, and dried in the sun.[3] From the analysis of MM. Mariano de Rivero and Boussingault[4] its composition appears to be similar to trona.

3. Egyptian natron, deposited on the sides of several lakes to the west of the Delta of Egypt, consists of *carbonate of soda, sulphate of soda, common salt, water, sand*, and other impurities in varying proportions. The carbonate of soda found in Egyptian natron contains, according to Poutet,[5] more carbonic acid than is found in the monocarbonate, but less than that contained in the sesquicarbonate. It is probably, therefore, monocarbonate mixed or combined with either sesquicarbonate or bicarbonate.

4. The carbonate of soda of the natron of Hungary (to which reference has already been made, see *ante*, p. 557) is probably similar in constitution to that of Egyptian natron; and the same, perhaps, holds good with respect to Bohemian natron.

PREPARATION.—According to Phillips and H. Rose, a crystallised sesquicarbonate of soda is deposited by boiling down and cooling a watery solution of the bicarbonate of soda. According to Hermann[6] it is formed by effervescence from masses of mixed carbonate and bicarbonate of soda.

PROPERTIES.—The crystals of trona belong to the oblique prismatic system. By heat, as well as by long boiling of its watery solution, the sesquicarbonate evolves one-third of its carbonic acid, and is converted into the monocarbonate.

COMPOSITION.—It is probable that there are two sesquicarbonates; one containing three, the other four atoms of water.

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Hermann.*	*Winckler.*
Soda	2	62	40·00	40·00	41·13
Carbonic acid	3	66	42·58	43·06	43·31
Water	3	27	17·42	16·94	15·56
Artificially prepared Sesquicarbonate	1	155	100·00	100·00	100·00

				Boussingault.	*Klaproth.*	*Beudant.* (Trona.)			*Phillips.*
	At.	*Eq.Wt.*	*Per Ct.*	(Urao.)	(Trona.)	In agglom'd cryst.	In radi fibres.	Walls of Cassar.	(Artificial Salt.)
Soda	2	62	37·805	41·22	37·0	37·428	38·63	32·67	39·72
Carb: Acid	3	66	40·244	39·00	38·0	39·274	40·13	33·53	40·00
Water	4	36	21·951	18·80	22·5	23·287	21·24	20·53	20·28
	1	164	100·000	99·02	97·5	99·989	99·99	86·73	100·00
Foreign Matters				0·98	NaO,SO^3 2·5			NaO,SO^3 1·96 NaCl 3·96 Earthy matter 7·33	
				100·00	100·0			99·99	

---

[1] *Traité élémentaire de Minéralogie*, 2ème édit. t. ii. p. 313, 1832.
[2] *Quarterly Journal of Science*, vol. vii. p. 297.
[3] *Ibid.* vol. i. p. 188.
[4] *Ann. de Chim. et Phys.* t. xxix. p. 110, 1825.
[5] *Journ. de Chim. Méd.* t. vi. p. 197, 1830.
[6] *Chemical Gazette*, vol. i. p. 142, 1843.

It is probabl
salt composed c
The white p
powders, and
carbonate of s
carbonate and l
EFFECTS AN
of potash. [Tl
recommended in
in the Deccan,
great efficacy.[1]
also was admini
stored. Mr. He
states that he h
medy in the trea
scription which
sesquicarbonate
given every half
or one drop of t
the aid of sugar
minister the dos
being arrested.
pepper, or of
continued: eve

3. S

HISTORY.—Th
it is termed *natr*
or mixed with ca
of soda of the sh
NATURAL His
alkaline or *acid*
PREPARATION.-
carbonate with ca
1. *By passing*
soda.—This is th
pœias, and still fo
is usually obtaine

CaO,CO^2+HO,SO

In some countries
where it is collect
At Apothecarie
of the carbonic ac

---

[1] *Lancet*, 1850, vol.
[2] For a description a
Dict. de l'Indust. t. iii

The *London College* gives no process, the salt being placed in the Materia Medica.[1]

The *Dublin College* gives the following directions for the preparation of this salt:—Take of Crystallised Carbonate of Soda of commerce, lbs. ij.; Distilled Water, Oij; Muriatic Acid of commerce, Oiss.; Water, Oiij; Chalk, in fragments, lb. j., or a sufficient quantity. Having diluted the muriatic acid with the water, and dissolved the carbonate of soda in the *distilled* water, manipulate with these solutions, and with the chalk, as directed in the formula for *Potassæ Bicarbonas* (*ante*, p. 493), employing also the arrangement of apparatus there described. With the view, however, of obtaining from the mother liquor an additional quantity of bicarbonate, it is not necessary that the evaporation should be preceded by a filtration.

In the manufacture of bicarbonate of soda "for the purpose of commerce, 160 lbs. of carbonate may be dissolved in 13 gallons of water, and carbonic acid thrown into the solution in a proper apparatus. The bicarbonate falls, as it forms, to the amount of about 50 lbs., and, being separated from the solution, may be conveniently dried by pressure in an hydraulic press. A fresh portion of carbonate is dissolved in the mother liquor, and the operation repeated as before."[2] By this method of proceeding, a very pure bicarbonate is procured; but the objection to this process is its costliness.

2. *By exposing solid monocarbonate of soda to an atmosphere of carbonic acid gas.*—This is the process ordered to be followed in the Edinburgh Pharmacopœia, and which is usually practised for obtaining the commercial bicarbonate. The monocarbonate rapidly absorbs carbonic acid under the development of heat, and becomes moist, owing to the evolution of part of the water of crystallisation.

The *Edinburgh College* orders the bicarbonate to be prepared as follows:—Fill with fragments of marble a glass jar, open at the bottom and tubulated at the top; close the bottom in such a way as to keep in the marble without preventing the free passage of a fluid; connect the tubulature closely by a bent tube and corks with an empty bottle, and this in like manner with another bottle filled with one part of Carbonate of Soda, and two parts of Dried Carbonate of Soda, well triturated together; and let the tube be long enough to reach the bottom of the bottle. Before closing the last cork closely, immerse the jar to the top in diluted muriatic acid contained in any convenient vessel: when the whole apparatus is thus filled with carbonic acid gas, secure the last cork tightly, and let the action go on till next morning, or till gas is no longer absorbed by the salt. Remove the damp salt which is formed, and dry it, either in the air without heat, or at a temperature not above 120°.

The carbonic acid gas is sometimes developed by the action of hydrochloric acid (produced in the manufacture of carbonate of soda from common salt) on chalk.[3]

Smith's process for the preparation of bicarbonate of soda consists in placing the ordinary carbonate of soda in a box, and surrounding it by an atmosphere of carbonic acid gas under pressure. As the bicarbonate combines with much less water of crystallisation than is contained in the carbonate, a considerable portion of water is liberated, which, saturated with part of the salt, is allowed to drain off: when the gas ceases to be absorbed, the salt is taken out and dried. On examination, it is found to have retained the original form of the pieces; but they have become of a porous and loose texture,

---

[1] [In the edition of the London Pharmacopœia for 1836 this salt was described as *Sodæ Sesquicarbonas*. In the present Pharmacopœia, the carbonate and bicarbonate of soda are placed among the articles of materia medica.—ED.]

[2] Brande's *Manual of Chemistry*.

[3] Knapp's *Chemical Technology*.

presenting the a
and having a sn
absorbs carboni
containing the
moisture to drai
rated with carbo
ground between
stones is too slo
economical proce
tained in the mo

3. *By conver*
of sesquicarbon
this salt was ord
ammonia to a sol
to drive off the a
The proportions
soda, three oun
water. Winckle
of sesquicarbona
ordered by MM.
of soda, 2 parts c

PROPERTIES.—
Thomson,[4] obliqu
sided tables. As
whitish powder.
portion of the c
restores the blue
effloresces superfic
becomes the anh
V. Rose, or 8 pa
solution loses first

Characteristic
mentioned for thi
tests for soda.
soda by the follow
by its causing neit
nor a white preci
by the quantity o
to it.

COMPOSITION.—
position :—

	Atoms.
Soda	1 ..
Carbonic Acid......	2 ..
Water..............	1 ..
Cryst. Bicarb. Soda	1 ...

---

[1] *Journal of the Phil*
States Dispensatory. F
process, see his *Nouv. T*

[2] *Lehrb. d. Pharm. C*

[3] *Pharm. Raisonnée,* t

[4] *Chemistry of Inorga*

According to the analyses of Berthollet and Berard, the crystals contain two equivalents of water.

The *pulverulent bicarbonate of soda* of the shops is usually a mixture of bicarbonate with some monocarbonate. "The proportion of alkali in bicarbonate of soda is 37·0 per cent., but the salt of commerce generally contains upwards of 40 per cent., owing to the presence of neutral carbonate in the state of protohydrate, which last salt may be separated by a small quantity of water" (Graham).

Purity.—When quite pure, a moderately dilute solution of this salt occasions no precipitate with bichloride of platinum, perchloric acid, or tartaric acid, by which its freedom from potash is demonstrated. When supersaturated with pure nitric acid, it gives no precipitate with either chloride of barium or nitrate of silver, by which the absence of sulphates and chlorides is shewn. To detect the presence of any monocarbonate of soda proceed thus:—Pour a small quantity of distilled water over the suspected salt; shake and allow the mixture to stand for a few minutes, and then pour off the clear solution. If now a very dilute solution of bichloride of mercury be added to the clear liquor no precipitate is produced if only the bicarbonate be present; if the solution be more concentrated, an opalescence or white precipitate is formed, which in a few minutes becomes red. If any monocarbonate or sesquicarbonate be present, a red precipitate is formed immediately on the addition of the bichloride.

It is soluble in water: the solution slightly changes turmeric to brown. From the solution neither Bichloride of Platina nor Sulphate of Magnesia, unless heat be applied, throws anything down: what Chloride of Barium throws down is soluble in hydrochloric acid. 100 grains of this substance added to diluted sulphuric acid evolve 51·7 grains of carbonic acid.—*Ph. Lond.*

"A solution in 40 parts of water does not give an orange precipitate with solution of corrosive sublimate."—*Ph. Ed.*

Physiological Effects.—The effects of this salt are analogous to those of bicarbonate of potash, than which it has a somewhat less disagreeable taste and a slighter local action. It is less caustic and irritant than the carbonate of soda. Its remote or constitutional effects are analogous to those of the alkalines already noticed.

Uses.—It is employed as an *antacid* in those forms of dyspepsia which are attended with an inordinate quantity of acid in the stomach; as a *lithonlytic* in those kinds of lithiasis which are accompanied with an excessive secretion of uric acid and the urates; as a *resolvent* or *alterative* in certain forms of inflammation, in glandular affections, in syphilis, and scrofula; and as a *diuretic* in some dropsical complaints.

The principal consumption of bicarbonate of soda is in the preparation of the effervescing draught, soda powders, and Seidlitz powders: in these the bicarbonate is mixed with a vegetable acid (either citric or tartaric, usually the latter). Taken in a state of effervescence, a solution of this kind is an agreeable and refreshing drink for allaying thirst, checking sickness, and diminishing febrile heat. The resulting soda-salt (tartrate or citrate) undergoes partial digestion in its passage through the system, and is converted into carbonate, which is found in the urine (see *ante*, p. 183). Hence, therefore, these effervescing preparations may be employed as diuretics and lithonlytics, instead of the simple carbonate or bicarbonate of soda, than which they are more agreeable. On the other hand, they are highly objectionable, and are to be carefully avoided, in the treatment of phosphatic deposits in the urine. Alluding to these cases, Dr. Prout[1] observes, "were I required to name the remedy calculated to do the most mischief, I should name the common saline draught formed of potash or soda, and *some vegetable acid*." [This opinion is directly opposed to the views of others who have treated of the phosphatic diathesis, whose experience goes to show that the greatest benefit is occasionally observed from the use of the citrate and tartrate of potash in certain forms of phosphatic deposit.[2] It is this salt which, under the name of sesquicarbonate of soda, has been used largely by Mr. Wakefield to check the premonitory symptoms of cholera (see *ante*, p. 564).—ED.]

ADMINISTRATION.—The dose of this salt is from ten grains to a drachm. In the preparation of effervescing draughts, a scruple of the powder sold in the shops as bicarbonate of soda usually requires about 18 grains of crystallised tartaric acid, or about 17 grains of the ordinary crystals of citric acid, or four fluidrachms of lemon-juice, to saturate it.

1. **PULVERES EFFERVESCENTES**, E.; *Effervescing Powders; Pulvis* [illegible]. Ph. Bath. (Tartaric Acid, ℥j.; Bicarbonate of Soda, ℥j. and grs. liv.; or, Bicarbonate of Potash, ℥j. and grs. clx. Reduce the acid and either bicarbonate separately to fine powder, and divide each into sixteen powders; preserve the acid and alkaline powders in separate papers of different colours.)

The *Soda Powders* of the shops consist of 30 grains of bicarbonate of soda, contained in a blue paper, and 25 grains of tartaric acid, in a white paper. When taken, they should be dissolved in half a pint of water. The flavour of the solution is improved by adding to the water, before dissolving the acid, one or two drachms of simple syrup, and either half a drachm of the tincture of orange-peel, or two or three drops of the essence of lemon.

Ginger Beer Powders (*pulveres effervescentes cum zingibere*) are sometimes made as soda powders, with the addition of five grains of powdered ginger and a drachm of powdered white sugar. Another and a better formula is the following:—White Sugar, ʒij.; Bicarbonate of Soda, gr. xxvi.; Powdered Ginger, gr. v.; Essence of Lemon, gtt. j. Mix, and put in white paper. The blue paper contains powder of tartaric acid, ʒss.

2. **PULVERES EFFERVESCENTES CITRATI**, D.—Take of crystals of Citric Acid, [illegible] Bicarbonate of Soda, ʒxj.; or Bicarbonate of Potash, ʒxiij. Reduce the acid and alkaline bicarbonates separately to a fine powder, and divide each into eighteen parts. The acid and alkaline powders should be kept in papers of different colours.

Pulveres Effervescentes Tartarizati, D.—These are of the same composition, excepting that ten drachms of tartaric acid are ordered in place of [illegible]

3. **PULVERES SEIDLITZENSES**; *Seidlitz Powders*.—These consist of two

---

[1] On the *Nature and Treatment of Affections of the Urinary Organs*, 2d ed. p. 145.

[2] [illegible], *Medical Gazette*, xiii. p. 35. 1851.

drachms of Tartarized Soda and two scruples of Bicarbonate of Soda contained in a blue paper, and half a drachm of powdered Tartaric Acid in a white paper. These are to be taken, dissolved in half a pint of water, while the liquid is in a state of effervescence. These form an agreeable and mild aperient. Why they are called *Seidlitz* powders I cannot understand, since they have no analogy to the constituents of Seidlitz water.

4. AQUA SODÆ EFFERVESCENS, E.; *Effervescing Solution of Supercarbonate of Soda; Soda Water, properly so called.* (Bicarbonate of Soda, ʒj.; Distilled Water, Oj. Dissolve the carbonate in the water, and pass into it, compressed by force, more carbonic acid than is sufficient for saturation. Keep the solution in a well-stoppered bottle.)—This solution is employed in the same cases as bicarbonate of soda. The additional quantity of carbonic acid contained in it renders it more agreeable, and not less effectual, as an alkaline agent, in its operation on the system generally. It is employed to counteract or prevent the inordinate secretion of uric acid and the urates; but both this and soda water powders are highly injurious in phosphatic deposits.

Aqua sodæ effervescens may be extemporaneously made by pouring carbonic acid water into a tumbler containing half a drachm of bicarbonate of soda.

The *Bottled Soda Water* of the shops is in general only carbonic acid water. *Webb's Soda Water* contains 15 grains of crystallised carbonate of soda in each bottle. If, after it has ceased to effervesce, tartaric acid be added to bottle soda water, the effervescence is not renewed unless an alkaline carbonate be present. A fraudulent imitation of soda water is said to have been practised, by adding a few drops of sulphuric acid to a solution of carbonate of soda in water, and instantly corking the bottle. The fraud may be detected by chloride of barium, which throws down a white precipitate insoluble in nitric acid. [An excellent effervescing liquid may be made by adding to the solution of carbonate of soda in a bottle a proper proportion of tartaric acid in large crystals, and corking it tightly.—ED.]

5. SODÆ CARBONATIS LIQUOR, D.; *Solution of Carbonate of Soda.* (Take of crystallised Carbonate of Soda of commerce, ℥iss.; Distilled Water, Oj. Dissolve and filter.)—The specific gravity of this solution is 1·026.

6. TROCHISCI SODÆ BICARBONATIS, E.; *Soda Lozenges.* (Bicarbonate of Soda, ℥j.; Pure Sugar, ℥iij.; Gum Arabic, ʒss. Pulverise them, and, with mucilage, beat them into a proper mass for making lozenges.)—Employed to relieve too great acidity of stomach.

61. SODÆ BIBORAS.—BIBORATE OF SODA OR BORAX.

Formula $NaO,2BO^3$. *Equivalent Weight* 101.

HISTORY.—The word *borax* is derived from the Arabic *baurak* (also written *baurach*), a term applied by the Arabians to the *νίτρον* or *nitrum* of the Greeks and Romans. It is probable that when the Arabians first became acquainted with our borax, they considered it as a kind of nitrum. Subsequently, however, when the difference between nitrum and biborate of soda became

known in Europ
probable that th
Perhaps the a
Pliny,[3] and whic
was termed *sant*
In modern tin
soda (*sodæ bo*
atomic weight of
Natural His
It has been foun
It occurs also in
Persia. About
lumboo], in Thi
and supplied by
consequence of it
over. The wate
The latter crystal
in large masses,
mix it with an ea
rating (effloresci
of *tincal* (*tinkar*
crude borax (*bo*
prisms, covered
fatty matter sapo
Mojon states that
rough borax cont
procured in China
(*sohaga*, Hindost
Preparation.
native borax (tinc
1. *By refining*
has always been
Venice; and henc
Afterwards it was
saponaceous matte
is said, calcine the
method is to wash
lime has been add

---

[1] Beckmann's *Histor*
"brilliant,"—a name gi
[2] *Search of Perfectio*
[3] *Hist. Nat.* lib. xxxi
Paulus Ægineta, vol. iii.
[4] Gairdner, *On Mine*
[5] Turner's *Account o*
[6] [The spontaneous se
soluble in hot than in
tures.—Ed.]
[7] Anderson's periodic
[8] Royle's *Essay on th*
[9] Ainslie's *Materia M*
[10] Leonhard, *Handb. d*

some chloride of calcium has been added; strain, evaporate, and crystallise. By the reaction of the chloride of calcium on the soapy matter, there are formed some chloride of sodium in solution, and an insoluble calcareous soap, which is got rid of by filtration. A third method of purifying tincal is to wash the crystals with a solution of caustic soda. Dissolve the washed crystals in water, add some caustic soda to the solution to precipitate the earthy matters, decant and evaporate the clear solution so as to obtain crystals.

Borax is usually crystallised in wooden vessels lined with lead, and which have the form of short inverted cones. Borax thus purified is called *refined borax* (*borax depurata* seu *purificata*).

2. *By saturating native boracic acid with soda.*—The mode of preparing boracic acid in Tuscany has been already described (see *ante*, p. 337). The rough or crude acid usually contains from 17 to 20, or more, per cent. of impurities.[1] It is converted into borax in the following way:—Dissolve carbonate of soda in water contained in tubs lined with lead and heated by steam. Add coarsely pulverised boracic acid. The evolved gas is passed through sulphuric acid, to detain any carbonate of ammonia which may be contained in it. Boil the liquor, and let it stand for ten or twelve hours. Then draw it off into wooden crystallising vessels lined with lead. Here *rough* or *crude borax* is deposited. This is refined by dissolving it in water, contained in a tub lined with lead and heated by steam; adding more carbonate of soda, and crystallising. The crystals are allowed to drain, and when dry are packed in chests. In this way is obtained *common* or *prismatic borax*.

Octohedral borax is obtained by employing more concentrated solutions: the crystals are deposited at from 174° to 133° F.[2]

Sautter has patented a dry process for preparing borax. It consists in mixing 38 parts of pure dry boracic acid with 45 parts of crystallised carbonate of soda, and placing the mixture upon wooden shelves in a heated room. The boracic acid expels the carbonic acid and some water, and combines with the soda.[3]

PROPERTIES.—Borax usually occurs in large, colourless, transparent prisms, belonging to the oblique prismatic system (*prismatic borax*), $NaO,2BO^3 10HO$. It also occurs in octohedrons (*octohedral borax*), $NaO,2BO^3,5HO$. In commerce, we frequently meet with it in irregular-shaped masses. Its taste is saline, cooling, and somewhat alkaline. It reacts on turmeric paper like an alkali. By exposure to dry air, it effloresces slowly and slightly. When heated, it melts in its water of crystallisation, swells up, and forms a light, white, porous substance, called *calcined borax* (*borax usta* seu *calcinata*). At a higher temperature it fuses into a transparent glass, called *glass of borax* (*borax vitrificata*), which is anhydrous borax, $NaO,2BO^3$. It is soluble in twelve parts of cold, or in two parts of hot water.

Characteristics.—Borax may be recognised by the following characters:—It reddens turmeric paper; it fuses before the blowpipe into a glass, which

---

[1] [The boracic acid of Tuscany is almost exclusively employed in the manufacture of borax. The production of boracic acid from this source alone is calculated to be, for 1854, from three and a half to *four millions of pounds*. Since 1846, it has been contracted for by one firm at the Burslem Potteries, in Staffordshire. This firm manufactures refined borax, and supplies the whole of Europe with it at monopoly prices.—ED.]

[2] Payen, *Ann. de Chim. et de Physique*, 3me sér. tome ii. p. 322, Juillet 1841; also Knapp's *Chemical Technology*.

[3] Knapp, *ibid.*

may be readily
chloride of gold
acid be added t
fired, burn with
borax, sulphuric
in crystals as th
for the most pa
base is determi
small quantity c
gives to the flan
salt. After the
and combustion

PURITY.—Bo
copœias.

"It is soluble in
throws down cryst

COMPOSITION.

Soda.................
Boracic acid..........
Water ....

Crystallised Pri
Common Bor

Octohedral b
It offers several

PHYSIOLOGICA
ascertained. Its
applied to sores,
doses, it causes v
a mild refrigeran
urine (see *ante*,

Borax is usual
the uterus; pro
attends this proc
ment, and favour
been termed an

Borax has be
system.[4] When
p. 339), borax w

The conclusio
chemical research

1. *Boracic Acid.*-
to ℥iij. it occasions

---

[1] Guibourt, *Hist. d*
[2] J. F. Meticke *De*
Dr. Copland, *Dict. of*
[3] Virey, *Bull. de P*
[4] Vogt, *op. cit.*; an
[5] See the Prize Ess
für die Pharmacie, B

vomiting. In smaller doses it becomes speedily absorbed, and is eliminated by the kidneys, whose secretion it promotes. As a medicine it has less value than carbonic acid, to which it is analogous.

3. *Borax.*—In a pharmacological point of view, this salt resembles carbonate or bicarbonate of soda. Like the carbonate it has an alkaline reaction, acts as an antacid, and, when in solution, absorbs carbonic acid, and dissolves fibrine, albumen, casein, and uric acid. Swallowed in large doses it occasions oppression of stomach, nausea, and vomiting. It becomes absorbed, and is afterwards eliminated by the kidneys and other secreting organs. Binswanger detected it in the blood of the portal vein, in the bile, and the saliva. It has, therefore, doubtless, an influence on the process of chymification. In very large and repeated doses it produces the injurious effects of the alkalies: as inflammation of the stomach and bowels, disordered digestion, and a scorbutic condition. On Binswanger himself the use of it caused an impetiginous eruption. The author asserts that borax has no peculiar or specific effect on the nervous system, sexual organs, or mucous surfaces. It has no specific power of exciting uterine contractions, of promoting menstruation, or of curing aphthous affections; though, like the carbonated alkalies, it may, by relaxing muscular fibres, slightly relieve spasm of the uterus, or by its liquefacient properties promote the evacuation of menstrual blood, or by its mild alkaline qualities improve the condition of the skin and mucous surfaces. As a lithonlytic for uric acid, Binswanger considers it more useful than any other salt; for, though its solvent power for this acid is inferior to that of carbonate of lithia, the rarity of the latter salt renders it less available. Borax acts as a solvent for uric acid, by yielding up part of its soda to form the soluble urate of soda; but it has no power of preventing the formation of this acid: it acts merely as a lithonlytic,—that is, as a solvent for the already formed acid.

4. The *borate of potash* and the *borate of ammonia* resemble borax in their action on the system.

5. *Tartarus boraxatus* (see *ante*, p. 553) resembles bitartrate of potash, than which it is somewhat stronger, because it is more soluble.

USES.—As a *local agent*, borax is employed as a detergent in aphthæ and ulceration of the mouth. In some skin-diseases it has been used with great benefit. In pityriasis versicolor (called also *liver spots* or *chloasma*), a strong solution of borax (as ℥ss. of borax to f℥viij. of water) is a most valuable remedy. It should be applied by a sponge or rag. A solution of ʒss. of borax in f℥viij. of rose-water is sometimes employed as a useful cosmetic. In gonorrhœa and leucorrhœa, an aqueous solution has been occasionally used as an injection with success. *Unguentum boracis* (composed of ʒj. of borax to ℥j. of lard) has been applied to inflamed and painful hemorrhoidal tumors, and to cracked nipples.

Internally, it has been used as a lithonlytic (see *ante*, p. 266); as a diuretic in dropsical affections; and with the view of influencing the uterus in the cases before mentioned. Dr. Copland recommends it, in conjunction with ergot of rye, to promote uterine contractions. I have occasionally employed it in amenorrhœa, but with doubtful success.

ADMINISTRATION.—The dose of it is from half a drachm to a drachm. As a detergent in aphthæ, it may be used in powder, mixed with sugar or with honey.

MEL BORACIS, L. E. D.; *Honey of Borax; Mellite of Borax.* (Borax, powdered, ʒj.; Honey [clarified, *L. D.*] ℥j. Mix.)—A convenient form for the employment of borax in the aphthæ of children. Dissolved in water, it may be employed as a gargle in ulceration of the mouth and throat.

62. SO

I

HISTORY.—
In 1737 it wa
Haupt describ
perlated salt (
when melted l
1785, showed
introduced int
of soda has be
the urine, it h
termed the *alc*
called *tasteles*
from the other
the *common* or
phosphate of s
basic water.

NATURAL E
nature.

a. IN THE INO
those of Steinbad

β. IN THE ORG
stituent of some
owes its alkaline
acid, to this salt.

PREPARATIO
for its preparati
Medica; that is

The *Edinburgh*
and f℥iv.; Carbon
acid; add gradual
evaporates; add s
boiling water thro
impurities subside
pints. Let the im
and heated to eb
until the acid is co
More crystals will
soda till the liquid
allowing it to cool.

The *Dublin Coll*
of Ox Bones, burn
Distilled Water, C
commerce, lb. xij.,
and placed in a lar
a glass or porcelai
acid. After the la
one gallon of disti

---

[1] Gai

[2] Joh

[3] *Res*

little water, so as to restore what has been lost by evaporation. Add now a second gallon of the water, and having well agitated the mixture, and continued the digestion for another hour, let the whole be thrown upon a calico filter; and when the liquid has ceased to trickle through, let the precipitate be repeatedly washed with boiling distilled water, until the washings, allowed to drop on blue litmus paper, redden it only in a very slight degree. Concentrate the filtered solution and washings to the bulk of one gallon, and, having set it by for twenty-four hours, pass it through a filter. To the filtered solution, raised to the temperature of 212°, gradually add the carbonate of soda, previously dissolved in two gallons of boiling water, until the mixture acquires a slight alkaline reaction, and then place the whole upon a calico filter. The clear solution which passes through, when concentrated until a film begins to form on its surface, will, upon cooling, afford crystals of phosphate of soda; and from the mother-liquor an additional product may be obtained by further concentration. The salt, when dried on blotting paper, should be preserved in a well-stoppered bottle.

The products obtained by the mutual reaction of sulphuric acid and bone-ash are carbonic acid, sulphate of lime, and a soluble superphosphate of lime; the latter remains in solution, while the sulphate is, for the most part, precipitated. On the addition of carbonate of soda to the liquor, phosphate of soda is formed in solution, subphosphste of lime is precipitated, and carbonic acid gas escapes. A slight excess of carbonate of soda promotes the formation of crystals of phosphate.

PROPERTIES.—This salt crystallises in oblique rhombic prisms belonging to the oblique prismatic system. The crystals are transparent, but by exposure to the air effloresce and become opaque. Their taste is cooling saline. They react feebly on vegetable colours like alkalies. When heated, they undergo the watery fusion, give out both their basic water and water of crystallisation, and form a white mass called *pyrophosphate of soda* ($2NaO,b\acute{b}PO^5$). The crystals of phosphate of soda require for their solution four times their weight of cold, or twice their weight of hot water: they are nearly insoluble in alcohol.

Characteristics.—As a soda-salt it is known by the tests for this base already mentioned. As a tribasic phosphate its characteristics have been already stated (see *ante*, p. 347). Another character by which this salt is known is its crystalline form.

COMPOSITION.—The following is the composition of this salt:—

	Atoms.	*Eq.Wt.*	*Per Cent.*	*Berzelius.*	*Clark.*	*Graham.*	*Malaguti.*
Soda	2	62	17·270	17·67	37·48	37·1	16·71
Tribasic phosphoric acid	1	72	20·056	20·33			18·80
Basic water	1	9	2·507	62·00	2·49	62·9	64·25
Water of crystallisation	24	216	60·167		60·03		
Crystallised Rhombic Phosphate of Soda	1	359	100·000	100·00	100·00	100·0	99·78

If this salt be dissolved in water, and the solution evaporated at a temperature of 90°, it crystallises with only fourteen atoms of water of crystallisation. $HO,2NaO,cPO^5,14HO$.

IMPURITY.—As met with in commerce, phosphate of soda is usually tolerably pure.

Exposed to the air it slightly effloresces. It is soluble in water. The solution turns the colour of turmeric slightly brown. What is thrown down by chloride of barium is white, and dissolves without effervescence in nitric acid. The precipitate thrown down by nitrate of silver is yellow (phosphate of silver), and is soluble in the same acid. At a red heat 100 grains give off 62·3 grains of water. What is thrown down by nitrate of silver from the remaining salt dissolved in water is white (pyrophosphate of silver).—*Ph. Lond.*

If the precip
in nitric acid, a
not entirely diss

"An efflorescent
and precipitated by
neous acid, will ren

PHYSIOLOGICA
it acts as a mild
doses it operate
essential constit
salt would be l
not constituents
more readily. M
as an agent acti
and modifying it
which there is
which the urine i
the view of suppl
constituents. M
been supported b

USES.—As a p
delicate persons,
slight taste and n
and inflammatory
employed in chol
ante, p. 185).

On account of
particularly applic
phate of lime i
this deficiency o
a defective deposit
the calcareous ph
however, is there
in the system: it
is no evidence tha

It has been a
purpose of supplyi
to be deficient: in
diminished. Simc
in diabetic urine is
ville,[3] Dr. Latham
diabetes with asser
stomach, to keep t

---

[1] Dr. O'Shaughnessy
[2] *Animal Chemistry,*
[3] Nicolas et Gueudev
[4] *Facts and Opinions*
[5] *Transactions of th*
of Physicians in Irelan

is one of the substances which have been employed as a solvent for lithic acid calculi.

ADMINISTRATION.—As a purgative, it is given in doses of from six to twelve drachms. It is best taken in broth or soup. As an alterative, the dose is one or two scruples three or four times a day.

SOLUTIO SODÆ PHOSPHATIS, E.; *Solution of Phosphate of Soda.* (Phosphate of Soda [free of efflorescence], grs. clxxv.; Distilled Water, f℥viij. Dissolve the salt in the water, and keep the solution in well-closed bottles.)—Used only as a test.

Phosphate of soda is principally valuable as a test for magnesia (see *Magnesia*). It is also used to precipitate certain metallic oxides, especially the oxides of lead and silver (see *Lithargyrum, Plumbi Acetas*, and *Plumbi Carbonas*).

63. Sodæ Hyposulphis.—Hyposulphite of Soda.

Formula NaO,S^2O^2. *Equivalent Weight* 79.

Hyposulphis natricus seu sodicus; *Sulphis sodæ sulphuratus.*—First noticed by Chaussier[1] in 1799. In the French Codex for 1839, the following directions are given for the preparation of this salt:—Take of Crystallised Carbonate of Soda, 320 parts; Distilled Water, 640 parts; Sublimed Sulphur, 40 parts. Dissolve the carbonate in the water, add the sulphur, and pass a stream of sulphurous acid through the solution. When the gas shall be in excess in the liquor, hyposulphite of soda is in solution. Then boil for a few minutes, filter, evaporate by a gentle heat to a third of its volume, and set aside in a cool place, that crystals may form.—In this process carbonic acid is evolved, and the hyposulphite of soda formed in solution. $NaO,CO^2+SO^2+S=NaO,S^2O^2+CO^2$. There are several other methods of preparing this salt. The following is given by Walchner[2] as a ready mode of preparing it:—Pure crystallised carbonate of soda is dried as much as possible, and reduced to a fine powder; 1 lb. of it is then mixed with 10 oz. of flowers of sulphur, and the mixture heated in a glass or porcelain dish gradually, until the sulphur melts. The mass, which cakes together, is kept at this temperature, and is divided, stirred, and mixed, in order that each part may be brought into contact with the atmosphere. The sulphuret of sodium formed, passes, under these circumstances, by the absorption of oxygen from the atmosphere, with a slight incandescence, gradually into sulphite of soda. It is dissolved in water, filtered, and the liquid immediately boiled with flowers of sulphur: the filtered, nearly colourless, strongly concentrated liquid affords hyposulphite of soda in very pure and beautiful crystals, and in large quantity. [It may be also obtained by boiling a saturated solution of prepared sulphite of soda with sulphur, and filtering the liquid which is afterwards concentrated by evaporation.—ED.]

According to Mitscherlich, hyposulphite of soda crystallises from a hot, watery solution without any water of crystallisation, NaO,S^2O^2; but from a less concentrated solution it separates in large, transparent, oblique prisms composed of $NaO,S^2O^2,5HO$. The crystals are odourless, and have a cool, afterwards bitter, taste. They readily dissolve in water, but not in alcohol. If sulphuric, nitric, or hydrochloric acid be added to a strong solution of this salt, sulphurous acid is disengaged, and sulphur is precipitated. With nitrate of silver in excess the hyposulphite of soda yields a white precipitate (AgO,S^2O^2), which ultimately becomes black, owing to its conversion into sulphuret of silver, AgS (which precipitates), and sulphuric acid, SO^3 (which remains in solution). [If the hyposulphite be in excess then the white hyposulphite of silver which is at first formed is immediately redissolved.—ED.] Its power of dissolving chloride of silver, as well as other argentine compounds (except the sulphuret) has led to its extensive use in the art of Photography.

---

[1] *Journal de la Société des Pharmaciens de Paris*, tom. i. p. 466, 4to. Nov. 1799.

[2] *Chemical Gazette*, vol. i. p. 524, 1843.

1. SYRUPUS SO
Hyposulphurosi.—I
a gentle heat, and
2. BALNEUM SO
dissolving from ℥j.
sufficiency of water
bath. Sometimes
bath while the pati

64

Two compounds

1. Th
2. Th

If an excess of
crystallised carbona
deposits crystals of
sided rectangular pr
sulphurous acid. I
the *neutral* or *mono*
in prisms. NaO,SO
A sulphite of so
sulphurous acid whi
is to be preferred to
disinfectant, and a
epidemic cholera rag
sulphurous acid fum
sulphites of soda to
A solution of bisu
The solution is prep
crystallised carbonat
if it retains any alk
much of the solution
arteries; and when
from putrefaction du
with great success in
are, that while it pre
and does not cause a

65. SODÆ SULPHAS.—SULPHATE OF SODA.

Formula NaO,SO^3. *Equivalent Weight* 71.

HISTORY.—Sulphate of soda (also called ***natron vitriolatum, Glauber's salt, sal catharticus Glauberi,*** or ***sal mirabile Glauberi***), was discovered in 1858 by Glauber.

NATURAL HISTORY.—It occurs in both kingdoms of nature.

α. IN THE INORGANISED KINGDOM.—As an efflorescence, the hydrous sulphate of soda is met with in various parts of the world. In the anhydrous state, mixed with a minute portion of carbonate of soda, it constitutes the mineral acid called *Thenardite*. Sulphate of soda is a constituent of many mineral waters (see *ante*, p. 314).

β. IN THE ORGANISED KINGDOM.—It is found in the ashes of some plants which grow by the sea-shore; as the *Tamarix gallica*. Lastly, it is found in some of the animal fluids; as the blood and urine.

PREPARATION.—Sulphate of soda is a product of several processes, especially of the manufactures of hydrochloric acid.

The *London* and *Dublin Colleges* place this compound in the Materia Medica.

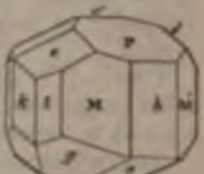
The *Edinburgh College* orders of the salt which remains, after preparing Pure Muriatic Acid, lb. ij.; Boiling Water, Oiij.; White Marble, in powder, a sufficiency. Dissolve the Salt in the Water, then gradually add as much Carbonate of Soda as is sufficient to saturate the Acid. Boil down until a pellicle appears, and the solution being strained, set it aside that crystals may be formed. The liquor being poured off, dry them.

The salt which remains after the distillation of hydrochloric acid is sulphate of soda, usually contaminated with some free sulphuric acid, to neutralize which the Edinburgh College uses marble (carbonate of lime).

In consequence of the enormous consumption of sulphate of soda in the manufacture of carbonate of soda, makers of the latter article are obliged to procure sulphate purposely, by the addition of sulphuric acid to chloride of sodium.

PROPERTIES.—It crystallises in oblique rhombic prisms, which belong to the oblique prismatic system. To the taste, this salt is cooling, and bitterish saline. By exposure to the air it effloresces. When heated, it undergoes the watery fusion, gives out its water of crystallisation, and thereby becomes a white solid, and at a red heat it again becomes liquid. One part of it dissolves in three parts of water at 60°, or one part of water at 212°. It is insoluble in alcohol.

FIG. 95.



Prism of Sulphate of Soda.

Characteristics.—Its characteristics are those for sulphuric acid and soda already mentioned. To these may be added its crystalline form. From the bisulphate of soda it is distinguished by its not reddening litmus, and by its less solubility.

Crystals of ***anhydrous sulphate of soda*** (NaO,SO^3) are distinguished by their form being the rhombic octohedron, and by their not losing weight when heated.

The ***octohydrated sulphate of soda*** is distinguished from the ***decahydrated sulphate*** (the common sulphate of the shops) by the shape of the crystals, which are quadrangular tables, or double four-sided pyramids; by their peculiar hardness, and by the quantity of water which they lose when heated.

as the *octohydr*

PURITY.—Th
ciently pure for
detected by nitra
a large scale, an
acid and the oxi
with lime, for th
the neutral sulp
crystallised alon
possesses a simil
sulphate of soda,
in dry air, the a
if the proportio
mine the comme
hot water, and a
the Glauber's salt

Exposed to the ai
not alter the colour
thing from a dilut
From 100 grains di
hydrochloric acid,
procured.—*Ph. Lon*

PHYSIOLOGICA
purgative salt, pr
of the stomach
antiplastic, as we
noticed.

USES.—It is e
other purgatives.
we wish to evacu

ADMINISTRATIO
so as to expel the

Moses[1] and Homer.[2] It has received various names, such as ***common salt*** (*sal commune*), *culinary salt* (*sal culinare*), *sea salt* (*sal marinum*), and *muriate* or *hydrochlorate of soda* (*sodæ murias*, E. vel *hydrochloras*). Its more correct appellation is *chloride* or *chloruret of sodium* (*sodii chloridum*, L.D. seu *chloruretum*). These names must not, however, be confounded with chloride of soda" or "chloruret of soda," or "chloruret of the oxide of sodium,"—terms which are applied to a bleaching solution of hypochlorite of soda (see *Sodæ Hypochloris*).

NATURAL HISTORY.—It occurs in both kingdoms of nature.

α. IN THE INORGANISED KINGDOM.—An enormous quantity of this salt is contained in the waters of the ocean. At an average calculation, sea water contains 2·5 per cent. of chloride of sodium (see *ante*, p. 302). It is found also in great abundance in mineral waters.[3] It has not hitherto been found in the oldest stratified rocks,[4] but is met with in all the later formations. Thus Mr. Featherstonhaugh[5] states, that salt or brine springs occur in certain parts of the United States,[6] in the *old transition slate rocks*. Salt springs occur in various parts of England, in the *coal measures*.[7] The rock salt of Cheshire, and the brine springs of Worcestershire, occur in the *old red sandstone group*.[8] The salt of Ischel in the Austrian Alps belongs to the *oolitic group*,[9] as does also that found in the lias in Switzerland.[10] The immense mass or bed of salt near Cardona, in Spain, and which has been described by Dr. Traill,[11] occurs in the *cretaceous group*.[12] The salt deposit of Wieliczka, near Cracow, belongs to the *supracretaceous group*.[13] Lastly, in the Crimea, salt is said to be daily accumulating in the inland lakes.

β. IN THE ORGANISED KINGDOM.—It is found in plants which grow by the sea side, in the blood and urine of man, &c.

PREPARATION.—The salt consumed in this country is chiefly procured by the evaporation of the water of brine springs. The salt districts are Northwich, Middlewich, and Nantwich, in Cheshire; Shirleywich, in Staffordshire; and Droitwich, in Worcestershire. In Cheshire, the rock salt (called also *fossil salt*, *sal fossilis* or *sal gemmæ*) constitutes two beds, which vary in thickness from 4 to 130 feet, and are separated by a bed of clay, ten or twelve feet thick; the uppermost bed of salt being 30 or more feet from the surface of the earth. It is for the most part of a reddish colour, but is also met with in transparent, colourless masses. It is called in commerce *Prussia rock*, and is largely exported for purification. Brine springs are met with both above and below the level of the beds of rock salt.

The brine is pumped up into cisterns or reservoirs, from which it is drawn when wanted into large oblong wrought-iron evaporating pans, which are usually worked with four or more fires. If the brine be not completely

---

[1] *Gen.* xix. 26; *Lev.* ii. 13.

[2] *Iliad*, lib. ix. 214.

[3] Gairdner, *On Mineral Springs*, p. 12.

[4] De la Beche, *Researches in Theoret. Geol.* p. 31.

[5] *Phil. Mag.* N.S. vol. v. p. 139; vol. vi. p. 75; and vol. vii. p. 198.

[6] For an account of the American salt formation, consult J. Van Rensselaer's *Essay on Salt, containing Notices of its Origin, Formation, Geological Position, and principal Localities; embracing a particular Description of the American Salines*, New York, 1823.—This author states that the American salt formation occurs in the old red sandstone.

[7] Bakewell, *Introd. to Geology*, 4th edit. p. 252.

[8] *Trans. Geol. Society*, vol. i. p. 38, and vol. ii. p. 94.

[9] Sedgwick and Murchison, *Phil. Mag.* N.S. vol. iii. p. 102.

[10] Bakewell, *op. cit.* p. 253.

[11] *Trans. Geol. Society* vol. iii. p. 404.

[12] De la Beche, *op. cit.* p. 293.

[13] *Ibid.* p. 270.

Surface

FIG

a. Bell mouth.
b. Six-inch timbers,
c. Water gallery.
d. Cylinder of brick
sill.
f. Three-inch timbers
g. Gutters.
h. Four-inch timbers.
i. Ditto, with clay p

Water Gallery ......

Rock Head............
Rock Salt ....

Rock Salt ....

Fair Rock..............

Good Rock...............

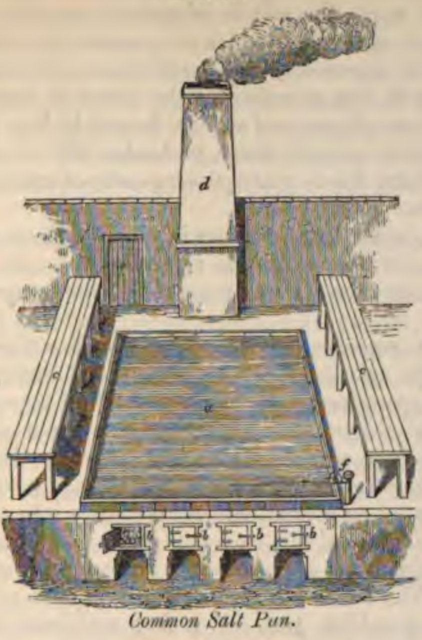
Inferior Rock...........

Middling Rock ....

Best Rock ....

Section of t

FIG. 97.

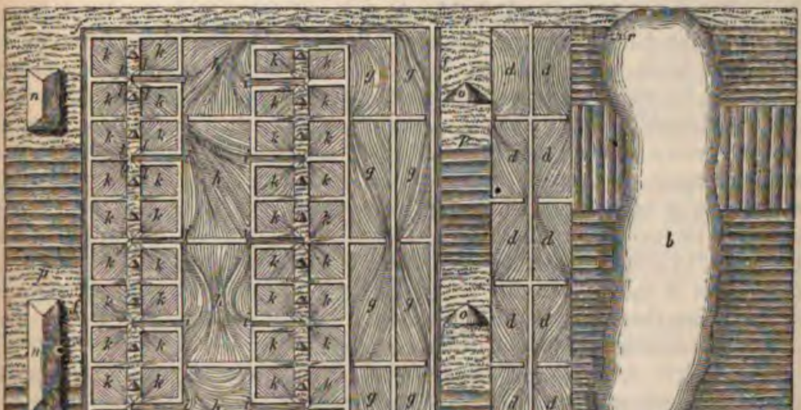


a. A flat shallow pan, varying in width and length from 20 feet and upward, and 15 inches deep, made of thick wrought iron.
b. Fire-places, the flues of which go direct to the chimney.

c. Hurdles on which the salt is drawn, to allow it to drain before it is conveyed to the store.
d. Chimney at extremity of pan.
e. Door of the store.
f. Feed-cock supplying brine to the pan.

Common Salt Pan.

FIG. 98.



Salt Marshes.

a. Sluice by which the sea water is admitted. *b*. Reservoir. *c*. Subterranean channel by which the water passes from *b* into *d*. *d*, *d*. First series of brine-pits or salt-pans. *e*. Subterranean channel by which the water passes from *d* to *f*. *f*. A long, narrow, circuitous canal. *g*, *g*. Second series of pans. *h*, *h*. Third ditto. *i*, *i*. Canal. *k*, *k*. Last series of pans. *l*, *l*. Subterranean channel by which the water passes from *i* to *k*. *m*. Subterranean channel by which the rinsings of the pans escape into the sea. *n*, *n*. Pyramidal heaps of bay salt. *o*, *o*. Conical heaps of ditto. *p*, *p*. Ground of the proprietors of the marshes.

saturated with chloride of sodium, a little rock salt is added to it. By the evaporation of the water, the salt is deposited in crystals. The impurities separate in the form of a scum (which is removed by a skimming-dish), and of a sediment called *pan-scale*, *pan-scratch*, or *pan-bake*. The grains or crystals of salt vary in size according to the degree of heat employed in their preparation. The *small-grained salt* is formed by the strongest heat, and constitutes the *butter*, *stoved*, *lump*, or *basket salt* of commerce, while the larger crystals, forming the *bay* and *fishery salts* of commerce, are formed at a lower temperature.[1]

In some places, chloride of sodium is obtained from sea water: but the mode of extraction varies according to circumstances. In France and on the shores of the Mediterranean, it is procured by solar evaporation, and is then called *bay salt*.

The French *salt marshes* (see fig. 98) are shallow basins or pans of clay, excavated along the sea shore. The water is admitted, by a sluice, into a reservoir, where evaporation goes on while mechanical impurities are deposited. It then passes by a subterraneous communication into a series of rectangular pans, and proceeds by a very circuitous route through them to another subterranean gutter, by which it is conveyed into a long, narrow, circuitous canal. From this it passes into a second, and subsequently into a third, series of salt pans. During the whole of this time it is undergoing evaporation, and when it arrives at the third series of pans it is so far concentrated that crystallisation is soon effected. The salt is known to be on the point of crystallising when the liquid assumes a reddish tint. It is then withdrawn from the pans, and collected upon the borders, in conical or pyramidal heaps, when it drains and dries. These operations begin in March, and are finished in September.[2] [Some improvements have been recently made in France in the manufacture of common salt from brine. Chloride of calcium, or chloride of magnesium, is added to the brine, by which addition the saline solution may be concentrated by heat to a considerable extent, without any deposition of salt therefrom taking place whilst it is in a heated state. This concentrated solution, when transferred to shallow vessels, deposits crystals of common salt on cooling. By this addition of chloride of calcium, or chloride of magnesium, the brine may be concentrated to the extent required, in closed boilers, without any deposition of salt therein. In the manufacture of common salt from rock salt, a heated solution of chloride of calcium, or chloride of magnesium, is employed, for the purpose of dissolving the salt from the rock salt, and thereby producing a solution, from which common salt is obtained by cooling.

The coolers or crystallising vessels are in each case furnished with partitions, by which means salt of various degrees of fineness may be produced, the finest salt being deposited in the division nearest to the closed boiler, where the solution will be the hottest, whilst the coolest or farthest division will produce salt of the coarsest quality. The chlorides of calcium and magnesium used, remain in the mother-liquors, and may therefore be collected and used again and again.

---

[1] For further information on the manufacture of common salt, consult Aikin's *Dictionary of Chemistry*, vol. ii. p. 118; Holland's *Agricultural Survey of Cheshire*; Dr. Henry, *Phil. Trans.* [illegible]; Mr. Furnival's *Wharton and Marston Patent Salt Refineries*, 1836; Dr. Brownrigg's *Art of making Common Salt*, 1748; and Dr. Jackson, *Phil. Trans.* No. 53, p. 1060.

[2] For further details, see *Phil. Trans.* No. 51, p. 1025; and Dumas, *Traité de Chimie*, t. ii.

The chief advantage, therefore, derivable from the adoption of this process by the manufacturer of common salt, appears to be, that of enabling him to concentrate his brine to the strength required for the production of salt of the crystalline character he requires; the deposition of salt in the boilers (which takes place during the process of concentration under ordinary circumstances) being prevented by the addition of suitable proportions of the chlorides of calcium and magnesium. We have no data before us as to the extent to which this process has been commercially applied, either in this country or in France.[1]—ED.]

At Lymington,[2] in Hampshire, salt is prepared from the sea water, which is admitted into a reservoir or pond, and from this successively into three series of brine pits or *salt-pans*, where the water is partly evaporated by solar heat. When the liquid has acquired a sufficient density, it is conveyed into rectangular iron pans, where it is evaporated by artificial heat. Eight hours are required to boil each charge to dryness. The salt is then removed into wooden troughs or cisterns, perforated by holes in the bottom, where it is allowed to drain; and is afterwards removed to the warehouse, where it also drains. The drainings from the wooden trough drop on upright stakes (old broom handles), and on these the salt concretes in the course of ten or twelve days, forming large stalactitic masses called *salt-cats*, each weighing 60 or 80 lbs. The residual liquor (*bittern*, or *the bitter liquor*) is received into underground pits, and during the winter season is used in the manufacture of Epsom salt (see *sulphate of magnesia*).

In cold countries, congelation is resorted to as a means of concentrating sea water; for when a weak saline solution is exposed to great cold, it separates into two parts: one almost pure water, which freezes; and the other which remains liquid, and contains the larger proportion of salt. Another method of concentration is by *graduating houses:* these are skeletons of houses, in which the water is pumped up and allowed to fall on heaps of brush-wood, or thorns, by which it is divided and agitated with the air, and evaporation promoted. The further concentration is effected by heat.[3]

PURIFICATION.—The *Edinburgh College* gives the following directions for the preparation of *pure chloride of sodium* (*sodæ murias purum*, E.)

> "Take any convenient quantity of Muriate of Soda; dissolve it in boiling water; filter the solution, and boil it down over the fire, skimming off the crystals which form; wash the crystals quickly with cold water, and dry them."
>
> A solution of this pure salt "is not precipitated by solution of carbonate of ammonia followed by solution of phosphate of soda: a solution of 9 grains in distilled water is not entirely precipitated by a solution of 26 grains of nitrate of silver."

The carbonate of ammonia and phosphate of soda are employed to detect the presence of any magnesian salt.

PROPERTIES.—It crystallises in colourless cubes, or more rarely in regular

---

[1] *Pharmaceutical Journal*, 1851-52, p. 231.

[2] Dr. Henry (*Phil. Trans.* 1810) has described the method of manufacture. In the summer of 1840, I visited the Salterns at Lymington, and can confirm the accuracy of Dr. Henry's statements. I found *Salicornia herbacea* growing abundantly in the salt-pans. The sp. gr. of the liquor in the pans is ascertained by glass bulbs (on the principal of Lovi's beads) placed in a wicker basket, which is immersed in the water by a long handle.

[3] See Knapp's *Chemical Technology*.

octohedrons.
as to form hollo
technically tern
2·17. The tas
matters, chlorid
ordinary salt is
of small quantit
When heated,
grained or bay
higher temperat
or diathermanoı
more readily tl
in water, and
solvent action
analysis of min
the chloride of
little more salt t
its weight of wa

Characterist
mentioned. As
In addition to
of the crystals o
property.

COMPOSITION.
tion:—

Sodium ....
Chlorine ....

Chloride o

The crystals co
little is frequentl

(
Kind of
Foreign Bay Salt { St. St. Ol
British Salt from Sea Water .... { Sc Sc Ly Di
Cheshire Salt ... { Cr Fi Co St

IMPURITIES.—The commercial salt of this country is sufficiently pure for all dietetical and therapeutical purposes; and its low price is a sufficient guarantee against adulteration. [It should give no opalescence with ammonia (magnesia), and it should not be precipitated by oxalate of ammonia (lime); but this last-mentioned impurity is generally present. The presence of these impurities renders common salt more soluble in boiling water.—ED.] In France, serious accidents have happened in consequence of the use of sophisticated salt.[1]

PHYSIOLOGICAL EFFECTS. α. *On Vegetables.*—In minute quantity, chloride of sodium is injurious to very few, if any, plants, and to some it appears to be beneficial. Used moderately, it is a most excellent manure to certain soils. In large quantities it is injurious, though unequally so, to all plants.[2]

β. *On Animals.*—To marine animals, common salt is a necessary constituent of their drink. It is relished by most land animals. "The eagerness with which many quadrupeds and birds press towards salt springs and lakes, situated in land districts, for the purpose of tasting their contents, indicates," says Dr. Fleming,[3] "a constitutional fondness for salt." In the ***Ruminantia***, the salutary effects of salt are especially observed. "They contribute powerfully," observes Moiroud,[4] "to prevent, in these animals, the influence of rainy seasons and wet pasturage, as well as damaged fodder. Given to animals intended for fattening, it imparts more consistence to the fat, and more taste to the meat." It appears to be offensive and injurious to many of the lower animals: hence, when rubbed on meat, it prevents the attack of insects; and when applied to the skin of leeches, causes vomiting.

γ. *On Man.*—Chloride of sodium serves some important and essential uses in the animal economy. It is employed, on account of its agreeable taste, by the people of all nations, from the most refined to the most barbarous; but the quantity taken varies with different individuals.[5] It is an invariable constituent of the healthy blood. Dr. Stevens[6] has shown that, in various states of disease (as cholera), there is a deficiency of the saline matter in the blood, and in those cases the blood has a very dark or black appearance. Some of the properties of the sanguineous fluid, such as its fluidity, its stimulating qualities, and its power of self-preservation, are probably more or less connected with its saline constituents. The chloride of sodium found in some of the secretions, as the bile and tears, doubtless serves some important purposes.

It is said that persons who take little or no salt with their food are very subject to intestinal worms. Lord Somerville, in his address to the Board of Agriculture, states that the ancient laws of Holland "ordained men to be kept on bread alone, ***unmixed with salt***, as the severest punishment that could be inflicted upon them in their moist climate: the effect was horrible;—

---

[1] Christison's *Treatise on Poisons*, 3d edit. p. 604; and Devergie, *Méd. Lég.* t. ii. p. 876.

[2] Davy, *Agricultural Chemistry*; and De Candolle, *Phys. Vég.* pp. 1262 and 1343. [Sea-water having accidentally become mixed with the water of a well from which a large nursery garden was watered, upwards of two thousand cuttings were destroyed thereby. By analysis it was found that the water contained seven grains of chloride of sodium in each pint, besides two grains of other saline matters (*Pharmaceutical Journal*, 1848, p. 143).—ED.]

[3] *Philosophy of Zoology*, vol. i. p. 316.

[4] *Pharmac. Vétérin.* p. 410.

[5] For an account of the dietetical effects and uses of salt, see the author's *Treatise on Food and Diet*.

[6] *On the Blood*.

these wretched
in their own st
aversion to sal
whole of her li

Considered i
operation. Th
redness. Take
spoonful or m
intestines, prod
and assists dige
Dr. Garrod asc
deficiency in po
is abstracted by
in salt beef tha
poison. A m
within twenty-f
stomach and int
the moderate us
lant to the mu
endosmotic actio
agrees with oth
Its chemical infl
other salts.

[M. Piorry ha
treatment of in
by Dr. Willemi
1. Common salt
large doses of co
cases; and even
ounces of water,
especially valuab
acts most severe
profession to give

Properly dilute
stimulant and res
becomes almost in
follow. Dr. Mac
of a rabbit which
resuscitation.[4]

USES.—The fo
of chloride of sodi

As a *vomit,* it
other emetics.[5]
and the ordinary

---

[1] *Medical and Phys*
[2] Christison, *Treatis*
[3] *Lancet,* vol. i. 185
[4] *London Medical G*
[5] Searle, *London Me*
Brailoff and Isenbeck, *i*

is one or two table-spoonfuls in a tumblerful of water. A tea-spoonful of flour of mustard assists its action.

As a *purgative* it is seldom employed, except in the form of enema. One or two table-spoonfuls of common salt, dissolved in a pint of gruel, form a very useful clyster for promoting evacuations from the bowels.

It has been used in some diseases with the view of *restoring the saline qualities of the blood*, especially in cholera (see *ante*, p. 185).

Common salt has been employed as an *anthelmintic* (see *ante*, p. 244). For this purpose it is exhibited in large doses by the mouth; or, when the worms are lodged in the rectum, a strong solution is administered in the form of enema. When leeches have crept into the rectum, or have been accidentally swallowed, a solution of salt should be immediately used.

As a *chemical antidote*, chloride of sodium may be administered in poisoning by nitrate of silver. As an *alterative and tonic*, it is useful in scrofula, and glandular diseases. As an *astringent* in hemorrhages, dysentery, and diarrhœa, it has been administered in combination with lime-juice or lemon-juice.[1] It is frequently employed as a *dentifrice*.

As an *external application*, salt has been used for various purposes. [It has been employed with success by M. Tavignot in cases of ulcerated cornea, general treatment being at the same time pursued.[2]—ED.] Thus a saturated solution, applied with friction, is employed as a counter-irritant and discutient in glandular enlargements and chronic diseases of the joints: as a stimulant, it is rubbed on the chest in fainting and asphyxia. A solution of salt is employed as a substitute for sea-water; for baths (cold and warm), affusion, the douche, &c. (See *balneum maris factitium*.)

ADMINISTRATION.—As a tonic and alterative, the dose is from ten grains to a drachm. As an emetic, from two to three table-spoonfuls in five or six ounces of warm water. As a cathartic, from half an ounce to an ounce.

ENEMA COMMUNE; *Common Clyster*. (Chloride of Sodium, ℥j.; Warm Gruel (or Barley Water), ℥xij. Mix.)—To this some persons add one or two ounces of oil (olive, castor, or linseed oil).

67. SODÆ HYPOCHLORIS.—HYPOCHLORITE OF SODA.

Formula NaO,ClO. *Equivalent Weight* 74·5.

HISTORY.—Hitherto this substance has been obtained only in either mixture or combination with chloride of sodium; and in this state it is usually called *chloride of soda*, *chloruret of the oxide of sodium*, or *oxymuriate of soda*,—names which must not be confounded with "chloride of sodium," "chloruret of sodium," and "muriate of soda,"—terms which are applied to common salt.

The disinfecting power of a solution of chloride of soda was discovered by Labarraque about 1820.[3]

PREPARATION.—1. Solid or dry chloride of soda (*sodæ chloridum siccum; natrum oxymuriaticum siccum*) may be prepared in the same way as chloride of lime (hereafter to be described), but substituting carbonate of soda, which has effloresced in the air, and fallen to powder, for the hydrate of lime. The product is a white powder, having an odour of hypochlorous acid, and composed of chloride of soda (*i. e.* hypochlorite of soda and chloride of sodium) and bicarbonate of soda. $4(NaO,CO^2) + 2Cl = 2(NaO,2CO^2) + NaO,ClO + NaCl$. By solution in eight parts of water, it yields the *liqueur de Labarraque.*[1]

---

[1] *Memoir of the late Dr. Wright*, p. 322.

[2] *Medical Times*, vol. xxiii. p. 99.

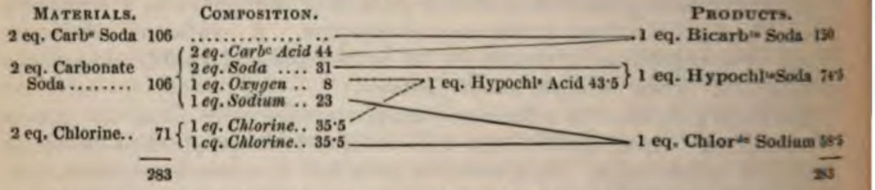
[3] Alcock, *Essay on the Use of the Chlorurets*, p. vi. Lond. 1847.

2. A solution of chloride of soda (*liquor sodæ chlorinatæ*, Ph. L. and D.; *hypochloricus sodicus aquâ solutus*, Fr. Codex), commonly called *liqueur de Labarraque*, or *Labarraque's soda disinfecting fluid*, may be prepared in the way above described, or by either of the two following methods:—

α. In the London Pharmacopœia it is directed to be prepared as follows:—

Take of Carbonate of Soda, lb. j.; Distilled Water, f℥xlviij.; Chloride of Sodium, ℥iv.; Binoxide of Manganese, ℥iij.; Sulphuric Acid, ℥iiss. Dissolve the carbonate of soda in two pints of water; then put the chloride of sodium and binoxide of manganese, rubbed to powder, into a retort; and add to them the sulphuric acid, previously mixed with three fluidounces of the water, and cooled. Heat (the mixture), and pass the chlorine first through five fluidounces of the water, and afterwards into the solution of the carbonate of soda above directed.

When the chlorine comes in contact with the solution of carbonate of soda, there are formed chloride of soda (hypochlorite of soda and chloride of sodium) and bicarbonate of soda, as above explained.



The essential and characteristic properties of this solution depend on the hypochlorite of soda.

The *Dublin College* give the following directions for the preparation of this solution:—

Take of Chlorinated Lime, lb. ss.; Water, *Cong.* ss.; Crystallised Carbonate of Soda, ℥vij. Blend well by trituration in a mortar the chlorinated lime with three pints of the water, and, having transferred the mixture to a stoppered bottle, let this be well shaken several times for the space of three hours. Pour out the contents of the bottle on a calico cloth, and to the filtered solution add the carbonate of soda dissolved in the remaining pint of water. Having stirred the mixture well for ten minutes, separate the liquid by a second filtration, and preserve it in a well-stoppered bottle. The sp. gr. of this liquid is 1·034.

β. In the French Codex the formula for this solution is similar to that of the Dublin College:—

Diffuse one part of dry chloride of lime through 30 parts of water; then add two parts of crystallised carbonate of soda, previously dissolved in 15 parts of water. Filter the mixture.

In this process double decomposition takes place; hypochlorite of soda and chloride of sodium are formed in solution, while carbonate of lime is precipitated.

---

[1] Duflos, *Chemisches Apothekerbuch*, Bd. i. S. 431, 3tte Ausg. 1847.

$(CaCl + CaO,ClO) + 2(NaO,CO^2) = NaO,ClO + NaCl + 2(CaO,CO^2)$. This process is more easy of execution than the preceding one. The strength of the solution depends on the proportions of materials employed.

PROPERTIES.—The solution of hypochlorite of soda (*Liquor sodæ chlorinatæ*, L. D.) has a yellowish colour, an astringent taste, and an odour of hypochlorous acid. It destroys the colour of vegetable substances; as litmus, turmeric, and sulphate of indigo. Previous to bleaching them, it reacts as an alkali on turmeric paper and infusion of red cabbage. By evaporation, crystals are obtained, which, by resolution in water, reproduce the disinfecting liquid. By exposure to the air the solution undergoes decomposition, and crystals of carbonate of soda are formed.

Characteristics.—The following are the essential characters of this solution:—

It decolorizes sulphate of indigo. It has the odour of hypochlorous acid. On the addition of hydrochloric acid, chlorine and carbonic acid are evolved, and chloride of sodium is left in solution $(NaO,ClO + NaCl + 2(NaO,2CO^2) + 4HCl = 4NaCl + 2Cl + 4CO^2 + 4HO)$. A solution of nitrate of silver throws down a white precipitate (*chloride of silver*), soluble in ammonia, but insoluble in nitric acid. Lime water causes a white precipitate (*carbonate of lime*). Oxalate of ammonia occasions no precipitate, showing the absence of lime. Bichloride of platinum produces no yellow precipitate, proving the absence of potash and ammonia. That the base of the solution is soda may be shown in two ways: evaporated to dryness, we obtain a residuum, which renders the outer cone of the flame of a candle, or the flame of a spirit lamp, yellow; saturated with hydrochloric acid, and evaporated to dryness, common salt is procured.

COMPOSITION.—Some chemists regard this liquid as an aqueous solution of chloride of soda and bicarbonate of soda. But its odour is that of hypochlorous acid; and the view usually taken of it is, that it is an aqueous solution of the *hypochlorite of soda, chloride of sodium,* and *bicarbonate of soda.*

Prepared according to the London Pharmacopœia, its composition will be nearly as follows:—

	Atoms.	*Eq. Wt.*	*Per Cent.*
Hypochlorite of soda	1	74·5	3·11
Chloride of sodium	1	58·5	2·44
Bicarbonate of soda	2	150·4	6·26
Water			88·19
Liquor Sodæ Chlorinatæ, *Ph. Lond.*			100·00

IMPURITY.—A solution of chloride of soda should not yield a precipitate on the addition of a solution of sulphate of magnesia. If a precipitate be obtained, it indicates the presence of the monocarbonate of soda, and the consequent imperfect saturation of the liquid with chlorine.

The colour of turmeric is first changed to red brown, and is afterwards destroyed by this solution. On the addition of diluted hydrochloric acid, carbonic acid and chlorine are evolved. The colour of a solution of sulphate of indigo is discharged by it. Lime-water produces with it a precipitate of carbonate of lime.—*Ph. Lond.*

PHYSIOLOGICAL EFFECTS. *a. On Animals.*—A solution of the chloride of soda acts more or less powerfully as a local irritant, according to the degree

of its concent
besides the ir
organic solids,
sequence, over
referred to by
into the perito
stant restlessne

β. On Man
the physiologic
doses, act as a
of gastro-enteri
the immediate
glassful of *Ea*
rigidity, which
one made by Se
caused tetanic
alkalies exercis

Chloride of
stimulant, toni
no real explana
to, and from w
dampness of th
effect of it. I
the continued e
discharges have
resolvent. All
duces in the co
fact, that the so
of soda, to whi
least, to be refe

USES.—The
antiseptic, and
sulphuric and
purposes the ch
its properties a
for the use of b
On this accoun
Hypochlorite
of soda. I wou
tried and comp
chloride of sod
paration, on the
of sodium, whic
generated by ch
furnishes one of
process. Henc

---

for mere disinfection, chloride of soda is preferable when we wish at the same time to prevent a renewal of putrefaction.

Chloride of soda is employed internally in all diseases commonly termed *putrid* or *malignant*—as typhus fever, and scarlatina maligna. It is indicated when there are great prostration of strength, fetid evacuations, and a dry and furred tongue. In such cases I have seen it of essential service, improving the quality of the secretions, producing a moist state of the skin, preventing collapse, and altogether acting most beneficially. It may be administered both by the mouth and the rectum. There are many other diseases in which it is stated to have been administered internally with apparent success: for example, in intermittents, as a substitute for the disulphate of quina, it has been recommended by Lalesque and Gouzée;[1] in secondary syphilis, it has been used by Dr. Scott[2] and by Cazenave;[3] in chronic skin diseases, and as a substitute for chlorine in bilious disorders, by Dr. Darling;[4] in scrofula, by Godier;[5] and in plague, by Neljoubin.[6] In some of these cases (as in syphilis and scrofula), the benefit obtained may have resulted from the bicarbonate of soda contained in solution.

As a *local* remedy, it is employed in diseases attended with fetid discharges, not merely as a disinfectant and antiseptic—that is, as a chemical agent destroying fetor, and preventing the putrefaction of dead matters (as gangrenous parts, the discharges from wounds and ulcers), although in these respects it is most valuable,—but as a means of stopping or relieving morbid action by changing the action of the living tissues. It frequently puts a stop to the further progress of gangrene; promotes the separation of the dead from the living parts; improves the quality of the secretions; and, at the same time, diminishes their quantity when this is excessive. It is applied to ulcers of various kinds (common, phagedenic, cancerous, syphilitic, and scrofulous) when attended with foul discharges, or a disposition to slough. It is of great service in some affections of the mucous surfaces. Thus it is used as a gargle to check ptyalism and affections of the mouth, whether arising from mercury or other causes. In scarlatina maligna, we apply it to check ulceration and sloughing of the throat. In coryza and ozæna, it has been injected into the nostrils with considerable benefit. In fetid and excessive discharges from the vagina and neck of the uterus or bladder, it is employed as an injection with at least temporary relief. It has also been applied in some skin diseases; as tinea capitis, eczema, scabies, and prurigo pudendi. The above are only a few of the cases in which chloride of soda has been used with most marked benefit. In conclusion, I may add that there are few, if any, remedies, the uses of which, as local agents, are so valuable and extensive as the chlorides of soda and lime.

ADMINISTRATION.—The *liquor sodæ chlorinatæ* (Ph. L. D.) may be administered internally in doses of from twenty to thirty drops or more, diluted with some mild aqueous liquid.

ANTIDOTES.—See *Calcis hypochloris.*

---

[1] *British and Foreign Medical Review*, April 1838.

[2] *London Medical Repository*, new series, vol. ii. 1836, p. 139.

[3] *Journ. de Chim. Méd.* t. iv. p. 140.

[4] *London Medical Repository*, new series, vol. ii.

[5] *Journ. Gén. de Méd.* 1829.

[6] Richter, *Ausf. Arzneim.* Suppl.-Bd. p. 439.

1. GARGARIS
(Solution of Chl
tion and slough

2. LOTIO SOI
of Chlorinated
foul and slough
equal parts of
general the stre

3. INJECTIO
(Solution of Ch
into the vagina

4. CATAPLAS
(Linseed-meal
soda and water.

68.

HISTORY.—
It was first an
quadrangular,
rhomboidale),
NATURAL H

Native nitrate
below the saline s
west, to the cours
of Tarapaca. It
parts.[3]
Native nitrate o
aggregation of irr
Colour, from snow
resembling chlorid
soda, 64·98; *sulph*
and marl, 2·60=9

EXTRACTION.—
and divided into
and water, or th
applied, until a
transferred to wo
dissolved salt re
each time, althou
coolers are empt
dried, packed in

---

[1] *Mémoires de l'Ac*
[2] *Opusc.* ii. 331.
[3] Hayes, in Sillim
Rivero, in the *Edinb.*
[4] *Ibid.*

COMMERCE.—In 1839, duty (6d. per cwt.) was paid on 107,922 cwts. In 1840, on 130,211 cwts.[1]

CRUDE NITRATE OF SODA.—The rough or crude Chili saltpetre (*sodæ nitras crudus; nitrum cubicum*) imported into Europe consists of crystals having a dirty or brownish appearance. Its composition is said to be as follows:—

	Hoffstetter.	*Lecanu.*	*Wittstein.*
Nitrate of soda	94·29	96·70	99·63
" potash	0·43	—	—
" magnesia	0·86	—	—
" lime	—	trace	trace
Chloride of sodium	1·99	1·30	0·37
Sulphate of potash	0·24	trace	—
Water	1·99	2·00	—
Insoluble matter	0·20	—	—
	100·00	100 00	100·00

Also small quantities of iodide of sodium and iodate of soda (Lembert).

The small quantities of the iodic salts found in Chili saltpetre explains a fact elsewhere noticed, that commercial nitric acid (which is frequently obtained from this salt) sometimes contains iodine.

After its arrival in this country, the crude Chili saltpetre is refined by solution and re-crystallisation. The salt is then termed *refined nitrate of soda* (*sodæ nitras depuratus*).

PROPERTIES.—It usually crystallises in obtuse rhombohedral crystals, which belong to the rhombohedral system. Its taste is somewhat bitter. In moist air it is slightly deliquescent. It is soluble in about two parts of cold water, and in less than its own weight at 212°. It fuses by heat.

Characteristics.—As a nitrate, it is known by the characters of this class of salts already stated; and the nature of its base is recognised by the tests for soda. The yellow colour which it communicates to flame, as well as the shape of its crystals, readily distinguish it from nitrate of potash.

COMPOSITION.—Crystallised nitrate of soda is anhydrous.

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Longchamp.*	*Wenzel.*
Soda	1	31	36·47	36·75	37·5
Nitric Acid	1	54	63·53	63·25	62·5
Crystallised Nitrate of Soda	1	85	100·00	100·00	100·0

IMPURITIES.—See *Potassæ Nitras*, p. 540.

PHYSIOLOGICAL EFFECTS.—Its effects are similar to those of nitrate of potash. According to Wolfers,[2] from two to four drachms of it may be taken daily without any hurtful effect. Velsen states that it does not so readily disturb digestion as nitrate of potash.

USES.—It is not employed in medicine in this country. As a substitute for nitrate of potash, it is used in the manufacture of nitric and sulphuric acids. It is employed by firework-makers; and also as a manure, especially for wheat.[3] On account of its deliquescence, it is unfit for the manufacture of gunpowder.

---

[1] *Trade List*, Jan. 5, 1841.

[2] Richter, *Ausführ. Arzneim.* Bd. iv. S. 251.

[3] *Journal of the Royal Agricultural Society of England*, for 1840 and 1841.

69. S

Fo

HISTORY.—T
to Dulk,[2] its re
terra foliata t
PREPARATION
ligneous acid,
in the processe
acetic acid by c
may form.

The *Dublin Coll*
with Carbonate of
a sufficient quantit
in a porcelain caps
shall be a slight e
form on its surfa
mother liquor, and
in a well-stoppere

PROPERTIES.-
says that a sat
cooled in a tall g
Its taste is cool
temperatures, th
effloresce and be
fusion, then give
igneous fusion.
a mixture of cha
parts of cold wa
in a close vessel,
quescent, is bett
arsenic, cadmiun
Characteristi
of the vapour of
soda salt is show
COMPOSITION.-

Soda ....
Acetic Acid .....
Water ....

Crystallis

PURITY.—It sl
and turmeric).
nised by chloride
insoluble in nitr

---

insoluble in both water and nitric acid, but soluble in ammonia, the presence of a chloride is to be inferred. Potash may be recognised by the beforementioned tests for this base, as well as by the deliquescence of the suspected acetate.

Physiological Effects.—Acetate of soda operates on the body like acetate of potash (see *ante*, p. 546), but it is probably somewhat milder in its action.

Uses.—It is rarely employed for medicinal purposes. It may, however, be used as a substitute for acetate of potash, over which it has the advantage of not being deliquescent. In pharmacy and the arts it is largely employed in the manufacture of acetic acid.

Administration.—The dose of it, as a diuretic, is from ℈j. to ʒij

70. Sodæ Valerianas.—Valerianate of Soda.

The *Dublin* is the only British College which gives a formula for the preparation of this salt.

Take of bichromate of potash, reduced to powder, nine ounces; fusel oil, four fluidounces; oil of vitrol of commerce, six fluidounces and a half; water, half a gallon; solution of caustic soda, one pint, or as much as is sufficient. Dilute the oil of vitriol with ten ounces, and dissolve with the aid of heat the bichromate of potash in the remainder of the water. When both solutions have cooled down to nearly the temperature of the atmosphere, place them in a matrass, and having added the fusel oil, mix well by repeated shaking, until the temperature of the mixture which first rises to about 150° has fallen to 80° or 90°. The matrass having been now connected with a condenser, heat is to be applied, so as to distil over about half a gallon of the liquid. Let this, when exactly saturated with the solution of caustic soda, be separated from a little oil that floats on its surface, and evaporated down until, the escape of aqueous vapour having entirely ceased, the residual salt is partially liquefied. The heat should now be withdrawn, and when the valerianate of soda has concreted, it is, while still warm, to be divided into fragments, and preserved in a well-stoppered bottle.

71. Sodæ Tartras.—Neutral or Bibasic Tartrate of Soda.

Formula $2NaO,C^8H^4O^{10}$; or $2NaO,\overline{T}$. *Equivalent Weight* 194.

This salt is obtained by saturating a solution of tartaric acid with either the carbonate or bicarbonate of soda. It is formed, therefore, in the preparation of the effervescing draught made with the above ingredient, or when *soda-powders* (see *ante*, p. 568) are dissolved in water. By evaparation the solution yields acicular crystals of tartrate of soda containing four atoms of water of crystallisation, $2NaO,\overline{T},4HO$. They are soluble in their own weight of water; but are insoluble in alcohol. In its medicinal properties, tartrate of soda resembles the tartrate of potash. It is a gentle aperient. If it be given so as to become absorbed, it operates as a diuretic, and renders the urine alkaline (see *ante*, p. 183). It may be used, therefore, in lithic acid deposits, but is by some considered objectionable when there are phosphatic deposits in the urine. Dose, as a purgative, ʒij. to ʒiv. or more. As a diuretic or lithic it must be given in smaller doses, and largely diluted with water, so as to ensure its absorption.—By adding to an aqueous solution of 150 grains of crystallised tartaric acid, either 168 grains of bicarbonate of soda or 286 grains of crystallised neutral carbonate, we obtain, in solution, tartrate of soda equal to 232 grains (or nearly ʒiv.) of the crystallised salt.

72. POTASSÆ ET SODÆ TARTRAS.—TARTRATE OF POTASH AND SODA.

History.—This salt was discovered by Seignette, an apothecary at Rochelle, in 1672; and hence it is frequently termed *Seignette's salt*, or *sel de*

Seignette.[1] Its composition was discovered by Boulduc and Geoffroy in 1731. He called it *alkaline salt, sal polychrest,* and *Rochelle salt* (*sal Rupellensis* vel *Rochellense*). To distinguish it from the sal polychrest (sulphate of potash) of other writers, it is sometimes denominated *sal polychrestum Seignetti.* It is often called *tartarised soda* (*soda tartarizata* seu *natron tartarizatum*). In the London Pharmacopœia it is denominated *sodæ potassio-tartras ;* but the term *potassæ sodio-tartras* would be probably more correct. The Dublin College calls it *sodæ et potassæ tartras.*

PREPARATION.—Two of the British Colleges give directions for its preparation :—

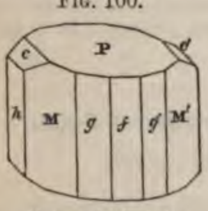
The *Edinburgh College* orders of Bitartrate of Potash, powdered, ℥xvj.; Carbonate of Soda, ℥xij.; Boiling Water, Oiv. Proceed for this preparation exactly as for the Tartrate of Potash.

The *Dublin College* gives the following directions :—Take of Crystallised Carbonate of Soda of Commerce, ℥ix.; White Bitartrate of Potash, in fine powder, ℥xij. or a sufficient quantity; Distilled Water, *Cong.* ss. Dissolve the carbonate of soda in the water, and to the solution, while boiling hot, gradually add the bitartrate, until a neutral solution is obtained. Let this be filtered, evaporated till a pellicle falls on its surface, and then set to crystallise. After twelve hours, the solution should be decanted off the crystals, and then, when dried on blotting paper, should be preserved in a bottle. By further concentrating the decanted solution, and cooling it, an additional crop of crystals may be obtained.

In this process the excess of acid in the bitartrate of potash is saturated by the soda of the carbonate; while the carbonic acid of the latter is disengaged.

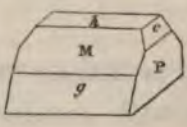
PROPERTIES.—This salt is met with in large, transparent, and regularly-shaped right rhombic prisms ; but, curiously enough, the crystals are frequently produced in halves (as in fig. 101). Their taste is mildly saline and bitter. Exposed to the air, they slightly effloresce. When heated, they undergo the watery fusion, evolve their water of crystallisation, and are decomposed : the residue consists of charcoal and the carbonates of potash and soda. They are readily soluble in cold, and still more so in hot water.

FIG. 100.



Prism of Rochelle Salt.

FIG. 101.



Natural Half of ditto.

Characteristics.—This salt may be recognised by the shape and size of the crystals. Sulphuric acid added to the aqueous solution throws down small crystals of bitartrate of potash; perchloric acid throws down perchlorate of potash; while the bichloride of platinum produces a yellow precipitate. When heated, Rochelle salt is decomposed,—various volatile substances are evolved, and the odour of caramel is given out. If the residuum be digested in hydrochloric acid, we obtain a solution of the chlorides of sodium and potassium: the chloride of potassium may be precipitated by bichloride of platinum, leaving chloride of sodium in solution, which may be detected by the tests already mentioned for this salt (see *ante*, p. 586).

PURITY.—Entirely and easily soluble in 5 parts of boiling water: 37 grains in solution are not entirely precipitated by 43 grains of nitrate of lead.—*Ph. Edin.*

It is dissolved by water: the solution does not alter the colour of turmeric or litmus

---

[1] Beckmann's *Hist. of Invent.* vol. iv. p. 616.

On the addition of sulphuric acid bitartrate of potash is precipitated. On the addition of nitrate of silver or chloride of barium nothing is thrown down, or should there be any precipitate, it is redissolved by the addition of water.—*Ph. Lond.*

COMPOSITION.—The composition of this salt is as follows:—

	Ats.	*Eq.Wt.*	*P.Ct.*	*Schulze.*			*Ats.*	*Eq.Wt.*	*P.Ct.*
Soda	1	31	10·3	13·3	or	Tartrate Potash	1	114	37·8
Potash	1	48	15·9	14·3		Tartrate Soda	1	97	32·2
Tartaric Acid	1	132	43·8	41·3		Water	10	90	30·0
Water	13	90	30·0	31·1					
Crystlsd. Tart. of Potash and Soda	1	301	100·0	100·0			1	301	100·0

Dr. Thomson[1] says, that when the crystals are free from all adhering moisture, they contain only eight atoms (or 25·4 per cent.) of water of crystallisation, and their equivalent weight is 283. Mr. R. Phillips also states that the water of crystallisation is only eight atoms.

PHYSIOLOGICAL EFFECTS.—It is a mild, laxative, cooling salt, very analogous in its effects to the tartrate of potash. Sundelin[2] says it is uncertain as a purgative,—sometimes failing, at others acting very slowly, but strongly, and with violent abdominal pain. He thinks it may be completely replaced in practice by a mixture of magnesia and sulphate of magnesia. When given in the form of dilute solution, and so as not to excite purging, it becomes absorbed, and renders the urine alkaline (see *ante*, p. 184, for a notice of Laveran and Millon's experiments). Hence its use should be carefully avoided in persons suffering with phosphatic deposits in the urine.

USES.—It is commonly employed as a mild aperient for females and other delicate persons. It may be used with advantage by those who are subject to excessive secretion of lithic acid or the lithates.

ADMINISTRATION.—It is given in doses of from ʒij. to ʒvj. or ℥j. It should be exhibited largely diluted with water. A very convenient mode of exhibition is in combination with bicarbonate of soda and tartaric acid in an effervescing condition (vide *Seidlitz Powders*, p. 567).

73. SAPONES SODAICI ET POTASSICI.—SODA AND POTASH SOAPS.

HISTORY.—The term *soap* (*sapo*) is usually applied to a combination of one or more fatty acids with a salifiable oxi-base; but it has also been extended to a compound of a resinous acid with an alkali. The substances, therefore, which at the present time bear the name of soaps, may be thus arranged:—

			EXAMPLES.
1. Fatty soaps	Soluble or alkaline	Ammoniacal	*Linimentum Ammoniæ*, Ph. L.
		Soda-soaps	*Sapo*, Ph. L.; *Sapo hispanicus.*
		Potash-soaps	*Sapo mollis*, Ph. L.
	Insoluble	Earthy	*Linimentum Calcis*, Ph. Ed.
		Metallic (plasters)	*Emplastrum Plumbi*, Ph. L.
2. Resinous soaps			*Sapo guaiacinus, &c.* Ph. Boruss.

On the present occasion it is intended to notice the soaps composed of fatty acids combined with potash or soda, and which constitute the *soaps commonly so called.* These substances, chemically speaking, are *oleates, margarates,*

---

[1] *First Principles*, ii. 440.
[2] *Hand. d. Heilmittellehre.*

and *stearates o*
stearates).

The Hebrew
by most comme
of some plant.
to render the ha
the best being p
states that there
(*sapo liquidus*),
the women. In
was discovered,
factured for more

NATURAL HIS
taneous formatio
exception to this
Chevreul, to con
united to much

PREPARATION.
soap-making :—"
of caustic potash
can be drawn out
must be added, a
on a deficiency of
is to separate the
fluous water. T
becomes very con
the surface. The
mon salt, both o
quantity ; soap be
as well as in a sat
to be complete wh
off into moulds, w
which should run
to this state in th
grainy particles at
of dissolving in al
this process the i
water; so that, al
commonly contains
to 30 per cent.
first ; but it is th
impurities to subsi
[or *mottled*] *soap*
and the grey, blue,
of insoluble soaps
when common salt

---

[1] *Je*
[2] *H*
[3] Pa

converted into soda-soap, entirely or partially, according to the quantity of salt, while chloride of potassium is formed. As this latter salt does not cause the soap to separate like common salt, it is necessary to use twice as much salt to separate the soap when it has been made with potash. If a soap of potash be required, it must be separated by caustic potash. In Germany, soda-soap is first made with potash, and the potash-soap is decomposed by common salt. In England and France, soda-soap is made directly with caustic soda.

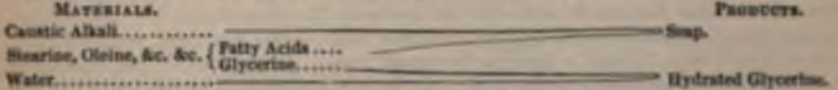
"The use of salt in this important process depends on the curious fact, that soap, like muscular fibre or animal membrane, cannot be moistened by a saturated solution of salt; that is, cannot deprive it of water. On the other hand, if these substances be moistened with water, or dissolved in it, the addition of dry salt in sufficient quantity will remove the whole of the water."[1]

THEORY OF SAPONIFICATION.—The fixed oils and fats, as they occur in nature, are for the most part mixtures or compounds of two or more fatty salts. *Stearine, margarine, oleine, cocinine* (or *coco-stearine*), *palmitine,* and *phocenine,* are the fatty salts of most frequent occurrence in the fats used for soap-making. They are each composed of, or at least are resolvable into, a sweet basic substance called *glycerine,* or the *oxide of glyceryle* (C^6H^7,O^5), and a fatty acid. Stearine yields *stearic acid;* margarine, *margaric acid;* oleine, *oleic acid;* cocinine, *cocinic acid;* palmitine, *palmitic acid;* and phocenine, *phocenic acid.*

Tallow consists chiefly of stearine with a little oleine. *Olive oil* is composed of margarine and oleine. *Almond oil* contains less margarine than olive oil. *Palm oil* contains oleine, margarine (?), and about two thirds of its weight of a white solid fat, called palmitine. *Cocoa-nut oil* consists of cocinine and oleine. *Train* or *fish oil* consists of oleine and phocenine.

When the oils and fats are acted on by a solution of the caustic alkali, the latter unites with the fatty acid, forming a soap, and disengages glycerine, which combines with water.

The following diagram illustrates the process of saponification:—



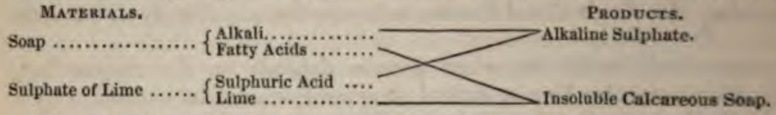
The phenomena observed during the action of resins on alkalies are different. Resins usually consist of one or more acids, which combine with alkalies to form resinous salts or soaps. Thus, ordinary yellow resin (or rosin) consists of two acids, called respectively pinic (chiefly) and silvic acids; and a soda soap made of this substance would, therefore, be a mixture of pinate and silvate of soda.

PROPERTIES.—The consistence, colour, odour, and sp. gr. of soap vary in the different varieties of this substance. The taste of all is slightly alkaline. All the alkaline soaps are soluble both in water and alcohol. The substance called *transparent soap* is prepared by evaporating an alcoholic solution of pure soap. When heated, soap fuses, swells up, and is decomposed, leaving a residuum of charcoal and alkaline carbonate. Most of the acids decompose soap: they unite with the alkaline base, and separate the fatty acids. The earthy salts (as sulphate of lime, sulphate of magnesia, alum, &c.) also decompose soap: the fatty acids unite with the earth to form an insoluble earthy soap, while the alkali of the soap combines with the acid of the salt. The *hardness* of sea, spring, and well water, depends on the earthy salts (principally sulphate of lime), which decompose soap (see *ante*, p. 293): hence tincture of soap may be used as a test of the hardness or softness of common waters.

---

[1] Liebig, in Turner's *Elements of Chemistry*, 8th edit. p. 1118.

The following diagram explains the action of sulphate of lime on soap:—



The metallic salts decompose soap, and give rise to metalline insoluble soaps.

Characteristics.—Soap may be partly recognised by its physical properties, especially by its feel, which is so well known that it is usually called *soapy*. The solubility of soap in water and alcohol is an important character, as well as its detergent quality, which depends on its power of rendering fatty and other matters soluble in water. The effect of heat on it also deserves notice: if the carbonaceous residuum be digested in weak hydrochloric acid, and the solution filtered and concentrated by evaporation, the nature of the alkaline base may be ascertained by applying the tests for potash and soda. Lastly, the action of acids and earthy and metallic salts on a solution of soap, as already noticed, serves to recognise soap.

Varieties.—A considerable number of soda and potash soaps are met with in commerce. Of these, some are *hard*, others *soft*; the former are prepared with soda, the latter with potash. This circumstance, therefore, forms the ground of their division into two classes.

Class 1. Hard or Soda Soap; *Sapo Sodaicus; Sapo natrinus; Sapo durus; Sapo spissus*, Pliny ?—The qualities of the hard or soda soaps vary according to the nature of the fatty matters with which these substances are prepared.

1. Castile or Spanish Soap; *Sapo; Sapo ex olivæ oleo et sodæ confectus*, L.; *Sapo durus; Spanish or Castile Soap made with olive oil and soda*, E.; *Sapo durus*, D.; *Sapo Hispanicus; Sapo Castiliensis; Marseilles* or *Venetian Soap; Olive Oil Soda Soap.*—This is prepared with olive oil and a solution of caustic soda. When pure, it has very little odour. It is hard, but in the fresh state may be easily worked or kneaded between the fingers; by keeping in warm air it becomes dry and pulverisable. It should not feel greasy, have a rancid odour, communicate an oily substance to paper, nor be covered with a saline efflorescence; but should dissolve completely and readily in distilled water or alcohol. Two varieties of it are known in commerce—the *white* and the *marbled*.

a. White Castile Soap.—This is purer than the following variety, but it is a weaker soap (*i. e.* it contains more water).

β. Marbled Castile Soap.—This variety is harder than the white kind. The marbled appearance is produced by adding to the soap, as soon as it is completely made and separated from the spent lye, a fresh quantity of lye, and immediately afterwards, a solution of sulphate of iron. A precipitate (probably composed of black oxide of iron, sulphuret of iron, and iron-soap) is formed; and this gives the dark-coloured streaks to the soap By exposure to the air these streaks become red, in consequence, probably, of the conversion of the black oxide into the red or sesquioxide of iron.

2. Almond Soap; *Almond Oil Soda Soap; Sapo amygdalinus*, French Codex.—This is the medicinal soap of the French. It is prepared with ten parts of soap boilers' lye (a solution of caustic soda) and twenty-one parts of almond oil.[1] In this country it is used as a toilet soap.

---

[1] Soubeiran, *Nouveau Traité de Pharmacie*, t. ii. p. 582, 2de édit.

3. COMMON SOAP; *Sapo vulgaris*, United States Pharmacopœia; *Sapo sebaceus*, Geiger; *Animal Oil Soda Soap.*—This is prepared with tallow and soda. Two kinds of it are in common use,—*curd soap* and *mottled soap.*

a. White Curd Soap.—This is made with pure or white tallow and soda. *White Windsor Soap* belongs to this class of soaps. It is to be made with one part of olive oil and nine parts of tallow; and *scented.*

β. Mottled Soap.—This is the common or domestic soap.—Refuse kitchen grease, called *kitchen stuff*, is used in its preparation.

4. YELLOW SOAP; *Rosin Soap; Resin Soda Soap.*—This is prepared with tallow, rosin, and caustic soda. Palm oil is also frequently employed in its manufacture.

5. COCOA-NUT OIL SOAP; *Marine Soap.*—This is prepared with cocoa-nut oil (usually mixed with tallow) and soda. It is used for washing with sea water.

In addition to the preceding there are several other varieties of soda-soap found in commerce. *Toilet* or *fancy soap* consists essentially of one of the preceding kinds of soap mixed with some fragrant volatile oil. *Silica soap* is a hard soap, with which silicate of soda is incorporated. *Sand soap* is common soap intermixed with sand. The term *clay soap* may be given to proposed mixtures of common soap with pipe-clay, fuller's-earth, soap-stone, or porcelain earth. *Chlorine soap* is intended to be soap mixed or combined with an alkaline hypochlorite (?) [*Cyanogen soap* is prepared with cyanide of potassium, and is used for removing stains produced on the skin by salts of silver.—ED.] *Bone soap* consists of ordinary soap intermixed with bone-gelatine dissolved in caustic potash: it is said to be sold under the name of *Liverpool poor man's soap.*[1]

2. Of Soft or Potash Soap; *Sapo potassicus; Sapo kalinus; Sapo millis; Sapo liquidus*, Pliny?—This kind of soap is made with caustic potash and oil or fat.

1. COMMON SOFT SOAP; *Sapo mollis*, D.; *Animal Oil Potash Soap.*—This is prepared with fish oil (whale, seal, or cod), tallow, and potash. Its colour is brownish or yellowish; transparent, interspersed with white specks or grains of stearic soap formed by the tallow, and which give the soap a granular texture like that of the fig.

2. OLIVE OIL POTASH SOAP; *Sapo mollis*, L. E.; *Sapo ex olivæ oleo et potassâ confectus*, L.; *Soft soap made with olive oil and potash*, Ed.—This is ordered in the London and Edinburgh Pharmacopœia, but is rarely met with.

The common soft soap, made with fish oil, suet, and potash, must not be used for this. —*Ph. Lond.*

COMPOSITION.—The following is the composition of several varieties of soap.[2]

HARD OR SODA SOAPS.

Constitutents.	Marseilles White.		Marseilles Marbled.	Foreign Castile, very dry, Sp. Gr. 1·0705.	London-made Castile, very dry, Sp. Gr. 0·9069.	Glasgow White Soap.	Cocoa-nut Oil Soap. (Marine Soap.)
	(*Braconnet.*)	(*D'Arcet.*)	(*Thenard.*)	(*Ure.*)	(*Ure.*)	(*Ure.*)	(*Ure.*)
Soda	10·24	6	6	9·0	10·5	6·4	4·5
Fatty Acids	68·40	60	64	76·5	75·2	60·0	22·0
Water	21·36	34	30	14·5	14·3	33·6	73·5
Hard or Soda Soap	100·00	100	100	100·0	100·0	100·0	100·0

SOFT OR POTASH SOAPS.

Constituents.	London Soft Soap.	Glasgow Soft soap.
	(*Ure.*)	(*Ure.*)
Potash	8·5	9·0
Fatty Acids	45·0	43·7
Water	46·5	47·3
Soft or Potash Soap	100·0	100·0

---

[1] For further details, see Knapp's *Chemical Technology.*

[2] See Gmelin's *Handbuch der Chemie.*

Purity.—The adulterations of soap are excess of water, lime, gypsum, pipe-clay, or silica. The first may be known by the consistence of the soap, and the great loss of weight which this substance undergoes in dry air. The other impurities may be detected by alcohol, which leaves them undissolved.

Physiological Effects. α. *On Vegetables.*—Soap, used as a manure, appears to promote vegetation.[1]

β. *On Animals.*—It does not appear to be poisonous to animals. Veterinarians employ it as a diuretic, and, in large doses, as a purgative.

γ. *On Man.*—Soap acts very much like the alkalines, already noticed. Its local operation, however, is much less energetic than either the caustic or even the carbonated alkalies. Hence it may be administered in considerable doses without causing irritation or inflammation. When swallowed, it very readily palls the appetite and disturbs the digestive functions. Perhaps these effects depend on the separation of the fatty acids in the stomach. Probably the fatty acids become more or less completely digested, for soap acts on the general system like the alkalies;—it promotes the secretion of urine, and communicates alkaline properties to this fluid. In large doses it acts as a purgative. I knew an idiot who had frequently eaten large lumps of soap without any ill effects; and I have heard of a pound of it being swallowed for a wager!

Uses.—As an *antacid,* soap is employed in poisoning by the mineral acids: it should be administered in the form of a strong solution, which effectually neutralises the acid without acting as an irritant. So also in those forms of dyspepsia which are attended with an excessive formation of acid, soap may be usefully employed to neutralise it. External parts burnt with the strong mineral acids, or with phosphorus, should be washed with a solution of soap. As a *lithonlytic,* soap has been used in those forms of lithiasis in which uric acid prevails. A mixture of soap and lime-water was once considered a most powerful solvent for urinary calculi. The Hon. Horace Walpole[2] gained great relief from it. By the action of lime-water on it, an insoluble calcareous soap and a solution of caustic soda are formed. As a *purgative,* soap is rarely exhibited alone: in combination with rhubarb, it may be employed with considerable benefit in habitual constipation and disordered conditions of the biliary functions. In the form of enema, a strong solution of it is sometimes used with great relief to dissolve hardened fæces, and to relieve obstinate constipation. As a *resolvent* or *alterative,* it was once much esteemed in enlargements and various chronic disorders of the viscera and glands; and, as the alkalies have been found useful in the same diseases, any good effects which may have been obtained by it are probably referable to its alkaline base. *Externally,* soap is frequently employed on account of its detergent, lubricating, and discutient qualities. Thus, in tinea capitis, scabies, and various other skin diseases, ablution night and morning with soap-water greatly contributes to the cure. On account of its lubricating qualities, it is a most convenient adjunct to liniments. The use of the liniment, cerate, and plaster of soap, are noticed below. Lastly, soap is used in pharmacy to render other medicines more soluble, or to give a proper consistence to various substances for the making of pills. Thus it is a constituent of various pills (e. g. *Pilulæ Rhei compositæ; Pilulæ Saponis compositæ;* and *Pilulæ Scillæ compositæ*). In some cases it acts as the *adjuvans*, assisting and promoting the operation of other medicines; as a *corrigens*, correcting their operation; and as a *constituens*, imparting an agreeable or convenient form. The addition of soap to aloes or extract of jalap is cited by Dr. Paris[1] as an instance in which soap fulfils all three of these objects.

---

[1] De Candolle, *Physiol. Végét.* p. 1343.

[2] *Philosophical Transactions,* xlvii. 43 and 472.

ADMINISTRATION.—The usual dose of soap, taken in a pilular form, is from grs. v. to ʒss. In cases of poisoning by the mineral acids, half a pint of strong solution of soap should be instantly administered.

1. LINIMENTUM SAPONIS, L. E. D.; *Soap Liniment; Opodeldoc.* (Soap, ℥iij.; Camphor, ℥j.; Spirit of Rosemary, f℥xvj. *L .D.* Castile Soap, ℥iiss.; Camphor, ʒx.; Spirit of Rosemary, f℥xviij.; Distilled Water f℥ij. *L.* Castile Soap, ℥v.; Camphor, ℥ijss.; Volatile Oil of Rosemary, fʒvj.; Rectified Spirit, Oij. *E.* Soap, ℥ij.; Camphor, ℥j.; Spirit of Rosemary, f℥xvj. *D.* The London College orders the spirit to be mixed with the water, and the soap and camphor to be added afterwards; but the Edinburgh and Dublin Colleges direct the soap to be first dissolved, and the camphor [and oil, *E.*] subsequently. (The Edinburgh College orders the mixture to be agitated briskly.)—If made with hard soap, as directed by the Pharmacopœias, this preparation is apt to solidify in cold weather. On this account druggists usually substitute common soft soap. The only objection to this is its unpleasant smell. Soap liniment is used as a stimulant and discutient, as well as, on account of its lubricating qualities, in local pains, sprains, bruises, rheumatism, &c. It is a constituent of *Linimentum Opii.*

2. CERATUM SAPONIS COMPOSITUM, L.; *Soap Cerate.* (Soap, ʒx.; Wax, ℥xiiss.; Oxide of Lead, powdered, ℥xv.; Olive Oil, Oj.; Vinegar, *Cong.* j. Boil the vinegar with the oxide of lead over a slow fire, constantly stirring them until they incorporate; then add the soap, and boil again in like manner, until all the moisture is evaporated; lastly, with these mix the wax, first dissolved in the oil.)—The subacetate of lead, formed by boiling the oxide of lead with vinegar, is decomposed by the soap, the soda of which combines with the acetic acid, and the fatty acids with the oxide of lead. The wax and oil serve to give consistence to the preparation. It is used as a mild cooling dressing for scrofulous swellings, and other local inflammations, as well as for fractured limbs: in the latter case, its principal use is as a mechanical support.

3. EMPLASTRUM SAPONIS, L. E. D.; *Soap Plaster.* (Soap, sliced, lb. ss.; Litharge Plaster, lb. iij.; Resin, ℥j. *L.* Litharge Plaster, ℥iv.; Gum Plaster, ℥ij.; Castile Soap, in shavings, ℥j. Mix the soap with the liquefied plaster, and boil down to a proper consistence, *E.*)—The quantity of soap here ordered is said by Mr. Scanlan[1] to be too much by one half; as when prepared by the formula of the London Pharmacopœia it is quite pulverisable, and falls into crumbs. The gum plaster ordered by the Edinburgh College will tend to obviate this defect. Boiling is unnecessary. (Castile Soap, in powder,

---

[1] *Pharmacologia.*

[2] Dr. Montgomery, *Observations on the Dublin Pharmacopœia*, p. 596.

℥iv.; Litharge Plaster, lb. iiss. To the plaster, previously melted over a gentle fire, add the soap, and heat them together, until they are thoroughly incorporated, *D.*)—This plaster, spread on leather, is used as a discutient and mechanical support.

4. EMPLASTRUM RESINÆ, D.; *Adhesive Plaster.* (Take of Resin, in powder, ℥iv.; Castile Soap, in powder, ℥ij.; Litharge Plaster, lbs. ij. To the litharge plaster, previously melted over a gentle fire, add the resin and soap, and mix them intimately.)—This plaster is less apt to irritate than the litharge plaster with resin, "owing to the much smaller proportion of resin. It is a very useful application to those abrasions of the skin which take place in consequence of long confinement to bed.[1]" [The *Emplastrum Resinæ* of the London and Edinburgh Pharmacopœias contains no soap.]

ORDER XIII. COMPOUNDS OF LITHIUM.

Lithium (L=6·5) is the metallic base of the alkali *lithia* (so called from λίθειος, *stony*, because it is exclusively found in the mineral kingdom). It is a constituent of several minerals (*petalite, triphane* or *spodumene, lepidolite, amblygonite*, &c.) It is also found in many mineral waters, in most of which it has been found in the state of carbonate; but in the Pyrmont and Sliatsch waters it exists in the form of sulphate; in the Kreuznach waters as the chloride; and in the waters of Aix-la-Chapelle and Burtscheid it is found in combination with phosphoric acid and soda. The medicinal properties of the compounds of lithium are unknown. The carbonate is the only one of them which it has been proposed to employ therapeutically.

74. Lithiæ Carbonas.—Carbonate of Lithia.

Formula, LO,CO^2. *Equivalent Weight* 36·5.

Found in many mineral waters; as those of Franzensbad, Klausen, Lubien, Elms, Teplitz, Bilin, Marienbad, Kissingen, Salzbrunn, Buchsäuerling, and Karlsbad.

Obtained by adding a strong solution of carbonate of ammonia to a solution of either sulphate of lithia or chloride of lithium. Or by decomposing sulphate of lithia by acetate of baryta, and calcining the resulting acetate of litha, by which it is converted into the carbonate. As usually met with, carbonate of lithia is a white powder, like carbonate of magnesia. It has a slight alkaline taste, and is soluble in water, both hot and cold; but insoluble in alcohol. When it has been fused, it is more difficultly soluble in water than when it is in the pulverulent condition. About one hundred parts of cold water are said to dissolve one part of carbonate of lithia. It dissolves more readily in water holding in solution carbonic acid, by which bicarbonate of lithia is formed. It is in this state, probably, that it exists in many mineral waters. By dissolving carbonate of lithia in hot water, filtering and slowly evaporating the solution, crystals of the carbonate are formed: they are said to be anhydrous. A solution of one part of the carbonate in 1000 parts of water has an alkaline reaction.

Carbonate of lithia has the following composition:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Hermann.*	*Schaffgotsch.*
Lithia	1	14·5	39·726	39	39·83
Carbonic acid	1	22	60·274	61	60·17
Carbonate of Lithia	1	36·5	100·000	100	100·00

---

[1] Dr. Montgomery, *op. cit.* p. 597.

No experiments have hitherto been made to ascertain the effects of carbonate of lithia when swallowed; they are at present, therefore, unknown. On account of its difficult solubility, its local action is not very energetic. Like the other alkaline carbonates, carbonate of lithia doubtless becomes absorbed, and is eliminated by the kidneys. Analogy would also lead us to infer that it is capable of rendering the urine alkaline. Although it is a constituent of many mineral waters, several of which are extensively consumed, its influence in them is quite unknown. It probably imparts very little activity to them, on account of the very minute proportion of it which they contain.

Attention has of late years been drawn to carbonate of lithia as a solvent for uric or lithic acid by Lipowitz,[1] Mr. Alexander Ure,[2] and Binswanger.[3] Lipowitz states, that one part of carbonate of lithia in 90 parts of water dissolved one part of uric acid at 122° F.; or four parts of uric acid at 212° F.: a solution of urate of lithia is formed while carbonic acid is evolved. Mr. Ure found that one grain of carbonate of lithia, dissolved in an ounce of distilled water, took up, at 98° F. (the heat of the blood), 2·3 grains of uric acid: and he says, that a human urinary calculus, composed of uric acid with alternate layers of oxalate of lime, lost five grains in weight by digestion for five hours in a solution of four grains of carbonate of lithia in an ounce of distilled water, at a blood-heat. And Binswanger states, that one part of carbonate of lithia, dissolved in 120 parts of water, takes up, at a blood heat, nearly four parts of uric acid. From the experiments of both Ure and Binswanger it appears that carbonate of lithia is a better solvent for uric acid, than either borax or the alkaline carbonates. The former has suggested the injection of a solution of carbonate of lithia into the urinary bladder as a litholytic, in calculi composed wholly or in part of lithic acid. "Of all the various menstrua hitherto recommended," says Mr. Ure, "none appears to promise more favourably than the carbonate of lithia, from the promptitude and energy with which, in dilute solution, it attacks calculi of this description. If by means of injections we can reduce a stone at the rate of a grain or more an hour, as the above experiment would lead us to anticipate, we shall not merely diminish the positive bulk of the calculus, but further loosen its cohesion; disintegrate it, so to speak, causing it to crumble down, and be washed away in the stream of urine. Cases may present themselves in which it may be expedient to conjoin the use of the lithontriptor; but only occasionally, and at long intervals. It is the frequency of repetition which renders that instrument so hazardous. It may be presumed, moreover, that the plan of throwing in a weak solution of this kind would generally exercise a beneficial influence in obviating irritation, by removing the sharp angular points and asperities of the broken fragments, where the practice of crushing is adopted."

It is probable that the internal employment of the carbonate of lithia might be resorted to with advantage in uric acid deposits. Aschenbrenner says it may be given in doses of from five to ten grains daily.

ORDER XIV. COMPOUNDS OF BARIUM.

Barium (Ba=69) is the metallic basis of the alkaline earth *baryta* (so called from *βαρύς, heavy*, on account of its great weight).

75. Barii Oxydum.—Oxide of Barium or Baryta.

Formula BaO. *Equivalent Weight* 77.

Baryta, also called *barytes*, or *heavy earth* (*terra ponderosa*) is the *protoxide of barium*. It is a greyish white or porous substance obtained by igniting nitrate of baryta. Its sp. gr. is about 4·7322. It forms with water a solid *hydrate of baryta* (BaO,HO), which is soluble in 20 parts of water at 60°, or 2 parts at 212°. From the hot solution *crystallized hydrate of baryta* (BaO,9HO) may be obtained.

---

[1] *Ann. der Chem. u. Pharm.* xxxvii. 348; and *Pharm. Central-Blatt für* 1841, p. 345.

[2] *Pharmaceutical Journal*, vol. iii. p. 71, 1843.

[3] Buchner's *Repertorium für die Pharmacie*, Bd. xlix. S. 199, 1848.

Baryta water (
with each of whic
in nitric acid. B
medicine. Their
sulphate, all the b
nitric acid, and th
cipitate (BaO,SO
carbonate of soda,
yellow tint to the
The characterist
All the salts of
canal are poisonou
insoluble is harmle
an alkaline sulphat
soluble barytic salt

76. BARYT

HISTORY.—I
which has, in co
NATURAL HIS

Witherite occur
Lancashire. *Bary*
met with at Alston

PREPARATION.
preparation of th
by the addition o
It may also be
sulphate of baryt
soda, and washin
PROPERTIES.—
crystallised. Its
of this mineral is
enamel, with the
carbonic acid. T
powder. It is al
cold, or 2304 par
bonate. It is mo
Characteristic
evolved gas is ca
(BaCl) by the test
COMPOSITION.—

Baryta............
Carbonic Acid.....

Carbonate Bary

---

[1] For some curious
vol. i. p. 324, 2d edit.

PURITY.—It should be white, odourless, tasteless, and entirely soluble in diluted hydrochloric or nitric acid, by which its freedom from sulphate of baryta is demonstrated. Neither caustic ammonia nor hydrosulphuric acid should produce any precipitate or change of colour in the hydrochloric solution, by which the absence of alumina and metallic matter (lead, iron, or copper) may be inferred. If excess of sulphuric acid be added to this solution, the whole of the baryta is thrown down in combination with the acid, and no precipitate should be occasioned by the subsequent addition of carbonate of soda, by which the absence of lime is shown.

"One hundred grains dissolved in an excess of nitric acid are not entirely precipitated with sixty-one grains of [anhydrous] sulphate of magnesia [or one hundred and twenty-five grains of the crystallised sulphate of magnesia]."—*Ph. Ed.*

PHYSIOLOGICAL EFFECTS. α. *On Vegetables.*—Germination does not take place in carbonate of baryta.[1]

β. *On Animals.*—Cows and fowls have been destroyed by swallowing the native carbonate.[2] Orfila[3] says a drachm of the powder killed a dog in six hours; but C. G. Gmelin[4] gave two drachms to a dog: vomiting took place, and the animal was well the next day. A drachm killed a rabbit in three hours. When applied to a wound it has proved fatal.[5] From the above experiments carbonate of baryta appears to act as an acro-narcotic poison: when swallowed it causes vomiting, inflames the alimentary tube, becomes absorbed, and acts specifically on the nervous system, causing convulsions, paralysis, and insensibility.

γ. *On Man.*—Only one case illustrating its action on the human subject has been published.[6] A young woman swallowed half a tea-cupful of the powdered carbonate: in two hours she had dimness of sight, double vision, ringing in the ears, pain in the head, and throbbing in the temples, a sensation of distension and weight at the epigastrium, distension of stomach, and palpitation. Subsequently she had pains in the legs and knees, and cramps in the calves. A day or two after, the cramps became more severe. These symptoms, slightly modified, continued for a long time.

USES.—Carbonate of baryta is employed in the preparation of the chloride of barium. It is not administered as a medicine.

ANTIDOTE.—A mixture of an alkaline sulphate (sulphate of soda or sulphate of magnesia) and diluted vinegar. (The use of the vinegar is to yield a soluble barytic salt, $BaO,\bar{A}$, on which the alkaline sulphate immediately reacts, and produces the insoluble sulphate of baryta.)

77. BARYTÆ SULPHAS.—SULPHATE OF BARYTA.

Formula BaO,SO^3. *Equivalent Weight* 117.

HISTORY.—Native sulphate of baryta, called *ponderous* or *heavy spar* (*spathum ponderosum*), was formerly confounded with sulphate of lime. In

---

[1] Vogel, in De Candolle, *Phys. Végét.* p. 1341.

[2] Parkes, *Chem. Essays*, vol. i. p. 330.

[3] *Toxicol. Générale.*

[4] *Versuche über d. Wirk. des Baryts, &c.* p. 8.

[5] Campbell, quoted by Christison, *Treatise on Poisons*, 3d edit. p. 532.

[6] Dr. Wilson, *Lond. Med. Gaz.* vol. xiv. p. 487.

1774, Scheele di
heavy spar, and
NATURAL HIS

It frequently occ
crystals are commo
of crystals. It oc
heavy spar is gene
Derbyshire. *Comp*
and is called *cawk.*
sulphate of baryta.

PROPERTIES.—
is inodorous and
white. The for

"White or flesh-

Characteristi
fused. "This
between this min
melts into a hard
powder, mixed w
barium, which,
hydrogen, and yi
the tests for the
COMPOSITION.-

Baryta........
Sulphuric Aci

Sulphate

PHYSIOLOGICA
inert.
USES.—Sulph
from which the
has been introdu
pure state it is s

78. BARII

HISTORY.—T
first termed *terr*
of barytes (*bary*
PREPARATION.
paration of this s
College.

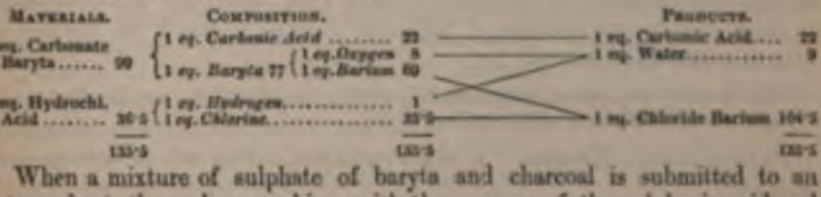
---

[1] Dr. Thomson, *O*
1836.
[2] *Toxicologie Géné*

The *Edinburgh College* directs it to be prepared either by saturating dilute hydrochloric acid with pure carbonate of baryta, or as follows:—Take of Sulphate of Baryta, lb. ij.; Charcoal, in fine powder, ℥iv.; Pure Muriatic Acid, a sufficiency. Heat the sulphate to redness, reduce it to a fine powder, mix the charcoal with it thoroughly, heat the mixture in a covered crucible for three hours at a low white heat. Pulverise the product, put it gradually into five pints of boiling water; boil for a few minutes; let it rest for a little over a vapour-bath; pour off the clear liquor, and filter it if necessary, keeping it hot. Pour three pints of boiling water over the residuum, and proceed as before. Unite the two liquids; and, while they are still hot, or, if cooled, after heating them again, add pure muriatic acid gradually so long as effervescence is occasioned. In this process the solutions ought to be as little exposed to the air as possible; and, in the last stage, the disengaged gas should be discharged by a proper tube into a chimney or the ash-pit of a furnace. Strain the liquor, concentrate it, and set it aside to crystallise.

The *Dublin College* also prepares it by two different processes. The first process is as follows:—Take of Carbonate of Barytes, coarsely powdered, ℥x.; Pure Muriatic acid, f℥viij.; Distilled Water, as much as is sufficient. Dilute the acid with a pint and a half of the water, add the carbonate of barytes, and, when effervescence has ceased, evaporate to dryness. Transfer the residue to a Hessian crucible, and, having evaporated to a low red heat for twenty minutes, suffer it to cool, then reduce it to a coarse powder, and boil it for ten minutes with a pint and a half of water. Pour off the solution, boil the undissolved residue with ten additional ounces of water, and again decant. Pass the decanted solutions through a paper filter, and having evaporated the resulting liquid to the bulk of about fourteen ounces, suffer it to cool that crystals may be formed. The mother liquor, by further evaporation and cooling, will yield additional crystals.—Or, Take of Sulphate of Barytes, lb. iss.; Lamp Black, ℥iv.; Pure Muriatic Acid, f℥xiv.; Distilled Water, a sufficient quantity. Heat the sulphate of barytes in a covered crucible, and, while red hot, throw it into distilled water. Let it now, after being reduced to a very fine powder in the manner directed in the formula for *Creta Preparata*, be mixed intimately with the lamp-black, and exposed in a Hessian crucible for two hours to a strong red heat. The crucible being removed from the fire, and permitted to cool, its contents are to be reduced to a coarse powder, and boiled for fifteen minutes with two quarts of water, after which the solution is to be poured off on a paper filter. The undissolved residuum is to be again boiled with one quart of water, and the resulting liquor decanted on the same filter. To the filtered solutions, placed in a large capsule beneath a flue with a good draught, let the muriatic acid be gradually added, as long as it produces effervescence, and then, by means of a sand heat, evaporate to dryness. Boil the residuum with two quarts of water, pass the solution through a paper filter, and having evaporated it down to one quart, suffer it to cool that crystals may be formed. By further concentration, the mother liquor will yield additional crystals.

When hydrochloric acid and carbonate of baryta are mixed together, one equivalent of hydrochloric acid reacts on one equivalent of carbonate of baryta; and the products are—one equivalent of carbonic acid, which escapes; one equivalent of water; and one equivalent of chloride of barium. $BaO,CO^2 + HCl = BaCl + CO^2 + HO$.


MATERIALS.
COMPOSITION.
PRODUCTS.
1 eq. Carbonate Baryta 99
1 eq. Carbonic Acid 22
1 eq. Baryta 77
1 eq. Oxygen 8
1 eq. Barium 69
1 eq. Hydrochl. Acid .... 36·5
1 eq. Hydrogen 1
1 eq. Chlorine .... 35·5
135·5
135·5
1 eq. Carbonic Acid 22
1 eq. Water 9
1 eq. Chloride Barium 104·5
135·5

When a mixture of sulphate of baryta and charcoal is submitted to an intense heat, the carbon combines with the oxygen of the sulphuric acid and of the baryta, and forms carbonic oxide, which escapes. $BaO,SO^3 + 4C = BaS + 4CO$. The residue digested in water forms a solution of sulphuret of barium. On the addition of hydrochloric acid, hydrosulphuric acid gas is evolved, and the solution, by evaporation, yields crystals of chloride of barium. $BaS + HCl = BaCl + HS$.

tered this medici
inflammatory affe
to ten grains, the
been enveloped i
of it has been u
scrofulous ophtha
as a test for sulp

ADMINISTRATI
barii chloridi).

ANTIDOTES.—
which form with
(In the absence
sulphate of lime
be removed from
sant symptoms c
may be employed.

LIQUOR BARII
of Chloride of
L. E.: Chloride
through paper.
solution, ten dro
ness is experience
sulphates. Com
or phosphates, in

7

Hydriodate of B
by either baryta or
Iodidum.)—Iodide o
and in alcohol; and
hydrated iodide of
tion: it absorbs car
periodide (ioduretted
in its use. "*Cautè,*
irritant and corrosiv
employed in medicin
both baryta and iodin
and in chronic infla
iodine, and mercury,
one grain, three tim
barii iodidi (compo
scrofulous swellings.

80. BARY

HISTORY.—This
PREPARATION.—

---

[1] Jahn,

of barium, see *ante*, p. 611], substituting pure nitric acid for the muriatic acid."—*Ph. Ed.*

PROPERTIES.—It crystallises in octohedrons. It is soluble in water, but insoluble in alcohol. It is entirely decomposed, with decrepitation, by a bright red heat, and furnishes pure baryta.

Characteristics.—As a nitrate, it is known by the tests for this class of salts already mentioned. The characters of the barytic salts have been before stated (see *ante*, p. 608).

COMPOSITION.—The crystallised salt is anhydrous. Its composition is as follows:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Berzelius.*
Baryta	1	77	58·7	58·4
Nitric Acid	1	54	41·3	41·6
Nitrate of Baryta	1	131	100·0	100·0

PHYSIOLOGICAL EFFECTS.—Similar to those of the chloride of barium.

USES.—It is employed in chemistry and pharmacy as a test. Fire-work makers use it to communicate a green tinge to flame.

SOLUTIO BARYTÆ NITRATIS, E.; *Solution of Nitrate of Baryta.* (Nitrate of Baryta, 40 grs.; Distilled Water, 800 grs. Dissolve the salt in the water, and keep the solution in well-closed bottles.)—Employed as a test for sulphuric acid and the sulphates. It is analogous in its action to a solution of the chloride of barium; but is employed when it is considered desirable to avoid the presence of a metallic chloride.

ORDER XV. COMPOUNDS OF CALCIUM.

Calcium (Ca=20) is the metallic base of the alkaline earth, *lime*. It is extensively distributed in both the inorganic and organic kingdoms.

81. CALX.—LIME.

Formula CaO. *Equivalent Weight* 28.

HISTORY.—Lime, and the mode of obtaining it by burning the carbonate, were known in the most remote periods of antiquity. Hippocrates[1] employed this earth in medicine. Dr. Black, in 1755, first explained the nature of the process for making it. In 1808, Davy showed that this substance was a metallic oxide; and hence it has been termed the *oxide of calcium*. It was formerly denominated *calcareous earth*. To distinguish it from the hydrate of lime, it is called *caustic lime*, or *quicklime* (*calx viva*), or *burned lime* (*calx usta*).

NATURAL HISTORY.—It occurs in both kingdoms of nature.

a. IN THE INORGANISED KINGDOM.—In the mineral kingdom, lime is found in the form of carbonate, sulphate, phosphate, silicate, arseniate, tungstate, borate, and titanate. Its base, calcium, occurs in combination with fluorine. "Lime is also disseminated through

---

[1] *Popularium*, ii. sect. 5.

PROPERTIES.—Chloride of barium crystallises in right rhombic plates or tables, sometimes in double eight-sided pyramids, which belong to the right prismatic system. To the taste, this salt is disagreeable and bitter. Its sp. gr. is 3·097. In dry warm air the crystals effloresce, but in the ordinary states of the air they undergo no change. When heated, they decrepitate, lose their water of crystallisation, and at a red heat fuse. At a white heat, according to Planiava, this salt is volatilised. It is soluble in both cold and hot water: 100 parts of water at 60° dissolve 43·5 of the crystallised salt,—at 222°, 78 parts. It is slightly soluble in ordinary rectified spirit, but it is nearly insoluble in pure alcohol. It is insoluble in strong nitric or hydrochloric acid.

Characteristics.—(See the tests for the *chlorides* and *barytic salts.*) Nitrate of silver added to a solution of chloride of barium causes a white precipitate (*chloride of silver*), soluble in ammonia, but insoluble in nitric acid. As a barytic salt, the chloride of barium is known by the following tests:—No precipitate is produced in a dilute solution of it by ammonia, hydrosulphuric acid, or ferrocyanide of potassium. But the soluble sulphates, phosphates, and carbonates, occasion with chloride of barium white precipitates (which are respectively *sulphate, phosphate*, and *carbonate of baryta*). The sulphate of baryta is insoluble in nitric and in nitromuriatic acid. Chloride of barium communicates a greenish-yellow tint to the flame of alcohol.

COMPOSITION.—Crystallised chloride of barium has the following composition:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Berzelius.*	*Phillips.*
Barium	1	69	56·326	85·201	85·5
Chlorine	1	35·5	28·980		
Water	2	18	14·694	14·799	14·5
Crystallised Chloride Barium	1	122·5	100·000	100.000	100·0

PURITY.—The crystals should be colourless, neutral to test paper, permanent in the ordinary states of the air (if they become moist or are deliquescent, the presence of chloride of calcium, or chloride of strontium, may be suspected), and their dilute aqueous solution should undergo no alteration of colour by the addition of ferrocyanide of potassium, hydrosulphuric acid, tincture of nutgalls, or caustic ammonia, by which the absence of metallic matter (as iron, lead, or copper) may be inferred. If excess of sulphuric acid be added, the filtered solution should be completely volatile when heated, and should occasion no precipitate on the addition of carbonate of soda, by which the absence of lime or magnesia is proved.

"One hundred grains in solution are not entirely precipitated by one hundred grains of [crystallised] sulphate of magnesia."—*Ph. Ed.*

PHYSIOLOGICAL EFFECTS. *a. On Vegetables.*—This salt is poisonous to plants.[1]

β. On Animals.—The action of chloride of barium on animals is, according to Sir B. Brodie,[2] analogous to that of arsenic. Locally, it operates as an irritant. After absorption, it affects the nervous system, the organs of

---

[1] Marcet, quoted by De Candolle, *Phys. Végét.*

[2] *Phil. Trans.* 1812, p. 205.

(*oxalate of lime*) on the addition of a solution of oxalic acid, or of an oxalate. Sulphuric acid affords no precipitate with lime water. Solutions of the calcareous salts are known by the following characters:—The hydrosulphurets, and, if the solution be dilute, the sulphates, occasion neither a precipitate nor a change of colour; the soluble carbonates, phosphates, and oxalates, produce white precipitates. The calcareous salts (especially chloride of calcium) give an orange-red tinge to the flame of alcohol.

COMPOSITION.—The following is the composition of lime and its hydrate:—

	Atoms.	*Eq.Wt.*	*Per Cent.*	*Berzelius.*		*Atoms.*	*Eq.Wt.*	*Per Cent.*	*Berzel.*
Calcium	1	20	71·43	71·91	Lime	1	28	75·676	75·7
Oxygen	1	8	28·57	28·09	Water	1	9	24·324	24·3
Lime	1	28	100·00	100·00	Hydrate of Lime	1	37	100·000	100·0

PURITY.—The lime used in the arts is never absolutely pure, but usually contains variable quantities of carbonate of lime, silica, alumina, and oxide of iron, and sometimes magnesia.

Water being added it cracks and falls to powder. It is dissolved in diluted hydrochloric acid without effervescence. This solution, ammonia being added in excess, precipitates nothing.—*Ph. Lond.*

It is slaked by water: muriatic acid then dissolves it entirely, without any effervescence; and the solution does not precipitate with ammonia in excess.—*Ph. Ed.*

PHYSIOLOGICAL EFFECTS. α. *On Vegetables.*—Quicklime is poisonous to plants. Notwithstanding this, however, it is used as a manure, its efficacy consisting chiefly in its chemical action on the organic matter of the soil.[1]

β. *On Animals.*—On dogs, Orfila[2] found that quicklime acted as a caustic poison, but not very energetically: and that it occasioned death by producing inflammation of the texture with which it comes in contact.

γ. *On Man.*—Quicklime, like the fixed alkalies, is a powerful escharotic. Its use in promoting the decomposition of the bodies of persons who have died of contagious diseases, or on the field of battle, and its employment by the tanner to separate the cuticle and hair from skins, sufficiently establish its causticity.[3] Its escharotic and irritant action is well seen in the ophthalmia produced by the lodgment of small particles of lime in the eye.

When applied to suppurating or mucous surfaces, lime water checks or stops secretion, and produces dryness of the part: hence it is termed a desiccant. In this property it differs from the fixed alkalies.

When administered *internally*, it neutralises the free acid of the gastric juice, diminishes the secretions of the gastro-intestinal membrane, and thereby occasions thirst and constipation. It frequently gives rise to uneasiness of stomach, disordered digestion, and not unfrequently to vomiting. After its absorption, it increases the secretion of urine, and diminishes the excessive formation or deposition of uric acid and the urates. With this exception, it does not, like the alkalies, promote the action of the different secreting organs, but, on the other hand, diminishes it, and has in consequence been termed an astringent. But it does not possess the corrugating action of the astringent vegetables, or of many of the metallic salts,—it is rather a drying remedy, or desiccant. In this respect lime differs from the alkalies, but is

---

[1] Johnston's *Lectures on Agricultural Chemistry.*

[2] *Toxicol. Générale.*

[3] [The desiccant properties of lime prevent it from accelerating putrefaction in the manner supposed. See on this subject a paper by one of us in the *Medical Gazette*, xlv. p. 17.—ED.]

analogous to the
the two. Weick
perty : and if this

A power of e
vessels and gland
tion. At any rat
softer and smalle
says that the exc
bring about a s
analogous to that
the symptoms in
the belly, obstinat

Uses.—Quickl
rarely resorted to.
(see *ante*, p. 488
an *antidote*, lim
Navier[4] in poison
antidotes, lime w
mineral and oxal
siderable celebrit
of Miss Joanna
p. 266), as well a
an *antacid* in d
times useful. "
covers its offensi
for nausea and v
found a diet excl
any other plan o
food. [It often
membrane of the
part of the soluti
the dyspepsia of g
panied with a copi
water serviceable.
ulcers attended wit
I have employed i
In diarrhœa, when
toms have subside
in leucorrhœa and
The internal use of
from various other

Lime water has
an antispasmodic,
sensibility of the

---

[1] *Pharmakod*
[2] *Heilmittelle*
[3] Christison,
[4] *Contre-poiso*
[5] *United State*
[6] Richter's *Au*

It has also been given as an alterative in glandular enlargements and venereal affections, and to promote the deposit of bone earth in diseases accompanied with a deficiency of this substance. In skin diseases (tinea capitis, scabies, and prurigo,) it has been applied as a wash.

ADMINISTRATION.—From half an ounce to three or four ounces may be taken three times a day. As already mentioned, it may be conveniently administered in combination with milk.

1. **LIQUOR CALCIS**, L. D.; *Aqua Calcis*, E.; *Lime Water*. (Lime, lb. ss.; Distilled Water, Oxij. Upon the lime, first slaked with a little water, pour the remaining water, and shake them together; then immediately cover the vessel, and set it by for three hours: afterwards, keep the solution, with the remaining lime, in stoppered glass vessels; and, when it is to be used, take from the clear solution, *L.* The *Edinburgh College* uses: Lime, *one part*, Water, *twenty parts*. The formula of the *Dublin College* is as follows:—Fresh-burned Lime, ℥ij.; Distilled Water, half a gallon. Having slaked the lime with an ounce and a half of the water, introduce it into a well-stoppered bottle with the remainder of the water, and shake well for the space of five minutes. After twelve hours the excess of lime will have subsided, and the clear lime water may be drawn off with a syphon as it may be required. When the entire of the solution has been withdrawn it may be renewed by shaking the sediment at the bottom of the bottle with another half gallon of water: and if the lime be pure, and the bottle be accurately stopped, this process may be successfully repeated three or four times.)—Lime water is colourless and transparent; but, by exposure to the air, becomes covered with a film of carbonate of lime, which is deposited on the sides and bottom of the vessel, and is succeeded by another. Hence it should be preserved in well-stoppered vessels with some undissolved lime, and, when used, the clear liquor poured off. Its taste is unpleasant and alkaline, and it has an alkaline reaction on vegetable colours. The dose of lime water is from f℥ss. to f℥iij. or f℥iv. three times a day. It may be conveniently administered in milk. Its uses have been above stated.

2. **LINIMENTUM CALCIS**, L. E. D.; *Liniment of Lime; Carron Oil.* (Olive Oil, *L. D.*, Linseed Oil, *E.*, Lime Water, of each equal measures. Mix and agitate them together.)—Linseed and olive oils are each composed of, or are converted into, oleic and margaric acids and glycerine. When mixed with lime water, an oleo-margarate of lime (*calcareous soap*) is formed. It has long been celebrated as an application to burns and scalds, and is employed for this purpose at the Carron Ironworks: hence one of its names. Though the London and Dublin Colleges order olive oil, it is almost invariably prepared with linseed oil. Turpentine is sometimes advantageously added to it.

84. CALCIS CARBONATES.—CARBONATES OF LIME.

Lime and carbonic acid combine together in several proportions, as follows:—

Dicarbonate	anhydrous	$2CaO,CO^2$.
	hydrated	$2CaO,CO^2HO$.
Neutral or Monocarbonate	anhydrous (*Calc Spar; Arragonite*)	CaO,CO^2.
	hydrated (crystals)	$CaO,CO^2,5HO$
Supercarbonate (Bicarbonate?)		$CaO,2CO^2$?.

Of these the neutral carbonate and the supercarbonate require to be noticed

1. Calci

History.—Som
employed in the
used for building
and Scyllis were re
about 580 years be
was probably identi
Natural Histo

a. In the Inorgan
of the earth, and occu
rocks, but more abund
towards the central an
calcareous spar and *ar*
presents itself under m
Granular carbonate
occurs in beds, but som
teemed primitive limes
sugar, *saccharoid carbo*
of Genoa, is the kind
employed for pharmace
burgh Pharmacopœias.
abundantly in the sout
of marine as well as ter
of the chalk of Englan
longed to poriferous an
April 5th, 1842), the c
lime, 98·57 ; carbonate
0·08 ; protoxide of man
[Wittstein[8] finds the

Carbonate of Li
Carbonate of M
Silica ....
Alumina, Protox
ganese, Sulph
Organic matter..

There are various oth
by mineralogists *schiefe*
thraconite, oolite, pisolite
mineral and common wa
sited when this is expell
β. In the Organise
obtained from the ashes
the lower classes. Thu
and Madrepores ; in the
animals it forms, with ph

---

[1] 1 *Chron.* xxix. 2.
[2] *Hist. Nat.* xxxvi.
[3] *Sat.* iii. lib. 2.
[4] On the chalk of the anc
[5] De la Beche, *Researche*
[6] See Bournon's *Traité C*
[7] Dr. Grant, *Lect. on Con*
[8] *Pharmaceutical Journa*
Hft. 2.

crab and lobster); and in the higher classes it is found in bone, but the quantity of it here is very small.

PREPARATION.—Several forms of carbonate of lime are employed in medicine—viz. *marble*, *chalk*, *precipitated carbonate of lime*, and *carbonate of lime from animals*. Most of these require to be submitted to some preparation before they are fitted for use.

1. Marble; *Marmor; Carbonas Calcis* (*dura*); *Massive Crystalline Carbonate of Lime; White Marble*, E.; *Marmor album*, D.—This is commonly employed for the preparation of carbonic acid, and for other purposes. White or statuary marble from Carrara should be selected, on account of its freedom from iron. It requires no preparation.

2. Chalk; *Creta; Calcis Carbonas* (*Friabilis in pulverem subtilissimum trita et elutriata*), L.; *Creta; Friable Carbonate of Lime; Chalk*, E.; *Creta*, D.—This is found in great abundance in the southern parts of England. It is ground in a mill, and the finer particles are separated by washing them over in water, letting the water settle, and making up the sediment into flat cakes, which are dried in the air. In this state it is called *whiting*. Two of the British Colleges give directions for the preparation of chalk by elutriation. By this means it is separated from silicious and ferruginous particles. The product is called *prepared chalk* (*Creta præparata*, E. D.) It is usually made up into little conical loaves.

The *Dublin College* orders of Chalk, lb. j.; Water, a sufficient quantity. Reduce the chalk to a fine powder, and having triturated this with as much water as will give it the consistence of cream, fill the mortar with water, and stir well, giving the whole a circular motion. Allow the mixture to stand for fifteen seconds, and then decant the liquid into a large vessel. Triturate what remains in the mortar, adding as much water as was previously used, and after allowing it to settle for fifteen seconds, again decant, and let this process be repeated several times. Let the fine sediment which subsides from the decanted liquid be transferred to a calico filter, and dried at a temperature not exceeding 212°.

The direction of the *Edinburgh College* is essentially the same.

3. Precipitated Carbonate of Lime; *Calcis Carbonas præcipitatum*, D.; *Creta precipitata; Precipitated Chalk.*—Carbonate of lime prepared by precipitation is employed by some druggists in the preparation of *aromatic confection* and *tooth-powder*. For these purposes it is superior to the ordinary prepared chalk, on account of its freedom from gritty particles. The Dublin College directs it to be employed in the preparation of the *hydrargyrum cum cretâ*, D. The following is the mode of obtaining it:—

Take of Chloride of Calcium, ℥v.; Crystals of Commercial Carbonate of Soda, ℥xiij.; Boiling Water, Oiv. Dissolve each salt in a quart of the water; mix the two solutions, and when the precipitate has subsided, draw off the supernatant liquor. Transfer the sediment to a calico filter, and wash it with boiling distilled water until the washings cease to give a precipitate with nitrate of silver. Finally, dry the product at a temperature not exceeding 212°.

It should be prepared with cold solutions, otherwise the deposit is finely granular.

[It is stated that chalk precipitated from *weak* cold solutions is heavier than that prepared from *strong* cold solutions. When submitted to microscopic examination, the heavy precipitated carbonate of lime has been found to agree very much in its properties with the heavy variety of carbonate of magnesia. It consists of rounded or pearly particles, having a radiated [illegible] cases is composed of concentric layers. The globules [illegible] black crosses and splendid colours in the quadrants [illegible] polarising microscope. Unlike the globules of heavy mag- [illegible] present uniform tints of colours; but coloured rings, like [illegible] spar.[1]—Ed.]

[illegible] of lime is substituted for the precipitated carbonate[2] [illegible] readily detected by the addition of either hydrochloric or [illegible] effervescence takes place with sulphate of lime. If sulphate [illegible] carbonate of lime, the fraud may be detected as follows:— [illegible] hydrochloric acid until effervescence ceases: the carbonate [illegible] the sulphate for the most part will be left undissolved. [illegible] a small portion of sulphate is dissolved, and, by the [illegible] of barium to the solution, the presence of sulphuric acid [illegible]

[illegible] procured on adding carbonate of soda to the solution [illegible] animal charcoal in muriatic acid, has also been used for [illegible][3] but the precipitate thus procured contains only 22 per [illegible] of lime, the remainder being calcareous phosphate. The [illegible] phosphate is easily recognised thus:—Digest in dilute hydro- [illegible] which both carbonate and phosphate of lime are dissolved, [illegible] caustic ammonia, which precipitates the phosphate [illegible] of soda being added to the filtered liquor, throws down [illegible]

[illegible] **from Animals.**—Carbonate of lime is obtained from [illegible] substances; as from oyster shells, crab's claws, crab's stones, [illegible] These substances yield carbonate of lime, intimately blended [illegible] of lime and animal matter.

[illegible] Shells; *Testæ præparatæ*, L.—See *Ostrea edulis*.
[illegible] Claws; *Lapilli Cancrorum præparati; Chelæ Cancrorum pre-* [illegible]
[illegible] Stones; *Lapides Cancrorum præparati; Prepared Crab's Eyes;* [illegible]—See *Astacus fluviatilis*.
[illegible]; *Corallium rubrum præparatum*.—See *Corallium rubrum*.

[illegible] carbonate of lime is a tasteless, odourless solid. When [illegible] a current of air, its carbonic acid is expelled, leaving [illegible] is considerable difficulty in expelling carbonic acid from [illegible]—Ed.] It is almost insoluble in water, one part of car- [illegible] parts of water to dissolve it. It is much more soluble [illegible] the solution reddens litmus, but changes the yellow [illegible] paper to brown; and by boiling, or exposure to the air, [illegible] acid, by which the carbonate of lime is deposited. [illegible] a dimorphous substance; that is, it crystallises in two [illegible] incompatible series of forms. Thus the forms of *calcareous* [illegible] the rhombohedric system, while *arragonite*[4] belongs to the right rectangular prismatic system. According to Gustav Rose,[1] both calcareous spar and arragonite may be formed in the humid way, but the first at a lower, the latter at a higher, temperature:[2] in the dry way, calcareous spar alone is formed. Both minerals doubly refract the rays of light (see *ante*, p. 143, figs. 22 and 23).

---

[1] [illegible], 1849, pp. 418, 419.

[2] [illegible], 1844.

[3] [illegible] 433 and 434.

[4] [illegible] pure carbonate of lime. Stromeyer found in this mineral as much as 4 per [illegible] strontia; and to the presence of this he attributes the modification of the [illegible]—Ed.]

Granular limestone (of which *white marble* is the purest kind) is massive, and consists of small grains of minute crystals, presenting a lamellar structure and brilliant lustre, but intersecting each other in every direction, and thereby giving a glimmering lustre to the mass.

Chalk is massive, opaque, when pure, white, and has an earthy fracture. It is usually soft to the touch, and adheres to the tongue.

Characteristics.—Carbonate of lime is recognised as a carbonate by the tests already mentioned for this class of salts. As a calcareous salt it is known by the characters for lime (see *ante*, p. 616.)

COMPOSITION.—Carbonate of lime has the following composition:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Marcet.*	*Stromeyer.*	*Berz. & Ure.*
Lime	1	28	56	56·1	56·35	56·4
Carbonic Acid	1	22	44	43·9	43·65	43·6
Carbonate of Lime	1	50	100	100·0	100·00	100·0

PURITY.—Pure marble or chalk should be perfectly soluble, with effervescence, in diluted hydrochloric acid, by which the absence of silica is shown. Ammonia should not cause any precipitate in this solution, by which its freedom from magnesia, alumina, oxide of iron, and phosphate of lime, may be inferred: nor should a solution of sulphate of lime throw down anything, by which the absence of baryta and strontian is proved.

It is entirely soluble in diluted hydrochloric acid, giving off bubbles of carbonic acid. The solution is not precipitated by hydrosulphuric acid, and after boiling it is not precipitated either by lime water or ammonia added in excess.—*Ph. Lond.*

"A solution of 25 grains in ten fluidrachms of pyroligneous acid,[3] when neutralised by carbonate of soda, and precipitated by 32 grains of oxalate of ammonia, continues precipitable after filtration by more of the test."—*Ph. Ed.*

PHYSIOLOGICAL EFFECTS.—The local effects of chalk are those of an absorbent, antacid, and mild *desiccant*. When swallowed, it neutralises the free acid of the gastric juice, and in this way alone must, by continued use, injure the digestive functions. It causes constipation—an effect commonly observed from the use of a few doses in diarrhœa. By the action of the free acids of the alimentary canal, it is converted into one or more soluble calcareous salts, which become absorbed. Hence the continued use of carbonate of lime is attended with the constitutional effects of the calcareous salts; and, consequently, the statements which have been made as to the influence of chalk over the lymphatic vessels and glands, and its effect in diminishing excessive secretion, may be correct. Sundelin[4] thinks it may even promote the deposit of bone-earth in diseases attended with a defi-

---

[1] *Lond. and Edinb. Phil. Mag.* June 1838.

[2] Colonel Yorke states that the deposit made by water on the interior of a copper boiler is artificial arragonite (*Proceedings of the Chemical Society*, No. 1).

[3] This quantity of acid is unnecessarily large. According to Mr. Phillips (*Lond. Med. Gaz.* N. S. vol. ii. 1838-9, p. 759), it is capable of dissolving more than four times the above quantity of chalk.

[4] *Heilmittellehre*, i. 179.

ciency of this su
has been erroneo
less likely to oc
that "after chalk
out, as it is apt
intestines.

USES.—As an
powder in moist
scalds, erysipelato
recommended by
those forms of dys
and as an antidot
been used in som
accompanied by,
are usually attend
which some hav
deficiency of lime

To diminish
can hardly be ref
not equally succe
Moreover, in man
of acidity can be
to chalk in most
logwood, catechu,
severe cases, acco

ADMINISTRATIO
mixture, in doses
number of officin

1. MISTURA C
(Prepared Chalk,
Water, f℥xviij. :
f℥iij.; Spirit of C
mucilage together,
E. Prepared Ch
f℥ss.; Cinnamon
then add the syr
able form for th
diarrhœa. Arom
catechu), and nar
to f℥ij.

2. PULVIS CRE
(Prepared Chalk,
each, ℥iij.; Long
fine powder, ʒiss.;
E. Take of Prep

Nutmeg, ℥ss.: rub the ingredients separately to powder, then mix and pass through a fine sieve, *D.*)—Aromatic and astringent. Used in diarrhœa. Dose, grs. x. to ℈j.

3. TROCHISCI CRETÆ, E.; *Chalk Lozenges.* (Prepared Chalk, ℥iv.; Gum Arabic, ℥j.; Nutmeg, ʒj.; Pure Sugar, ℥vj.: reduce them to powder, and beat them with a little water into a proper mass for making lozenges.)—Mildly antacid and astringent. Used in acidity of stomach and diarrhœa.

4. CAMPHORATED CRETACEOUS TOOTH-POWDER. (Precipitated Carbonate of Lime, ℥j.; Camphor, finely pulverised, ʒij.: mix.)—Extensively used as a dentifrice. On account of its softness, it does not injure the enamel: in fact, it scarcely possesses the requisite hardness to remove the foreign matters adherent to the teeth. It is objectionable on account of its insolubility, and its accumulation between the gums and the teeth. Objections have been made to the use of camphor as a dentifrice, owing to its supposed property of rendering the teeth brittle.[1] Although the validity of the objections is very doubtful, yet, as the camphor serves no useful purpose in the tooth-powder beyond that of a scent, it is advisable to substitute some other odoriferous substance for it.

2. Calcis Bicarbonas.—Bicarbonate of Lime.

Formula $CaO,2CO^2$. *Equivalent Weight* 72.

Supercarbonate of lime.—Carbonate of lime dissolves in water by the aid of carbonic acid. It takes up another atom of acid, and forms bicarbonate of lime. If this additional portion of acid be thrown off by ebullition, the carbonate of lime which it held in solution is deposited. In this way are formed the incrustations of carbonate of lime on the inner sides of steam boilers and tea-kettles. Caustic alkalies, or lime, also throw down the calcareous carbonate by saturating the excess of acid contained in the bicarbonate. On this is founded Professor Clark's patent process for the purification of common waters, to which allusion has already been made (see *ante*, p. 284). Bicarbonate of lime is a constituent of most spring and river waters. Dupasquier[2] says that it has a very feeble action on soap, and cannot, in the proportions in which it usually exists in ordinary potable waters, decompose it; a conclusion altogether opposed to that at which Professor Clark has arrived. If carbonic acid gas be transmitted through lime water, the liquid is at first rendered turbid by the formation of carbonate of lime; but by continuing the transmission of the gas, the liquor again becomes clear, owing to the conversion of the carbonate into the soluble bicarbonate of lime. If the liquid be charged with a sufficient quantity of carbonic acid, under pressure, it acquires the sparkling and effervescing qualities of soda water and other aërated liquors. Mr. Maugham has taken out a patent for an aërated water of this kind, which he calls *Carrara Water.* It is in fact an effervescing solution of supercarbonate of lime, and is taken like bottled soda-water. It is an objectionable beverage for those persons who are subject to habitual constipation or phosphatic deposits in the urine.

83. CALCIS TRIPHOSPHAS.—TRIPHOSPHATE OF LIME.

Formula $3CaO,cPO^5$. *Equivalent Weight* 156.

HISTORY.—Six or seven compounds of lime and phosphoric acid have been described: of these the only one employed in medicine or pharmacy is the

---

[1] *Lancet*, vol. ii. 1846, and vol. i. 1847; *Lond. Med. Gaz.* N. S. vol. xiv. 1847.

[2] *Des Eaux de Source et des Eaux de Rivière*, p. 164, 1840.

phosphate foun
phosphate of li
of bones consist
alluded to the d
author of it.
times called *s*
applicable to se
phosphoric acid,
of lime. Berze
calcique des os
NATURAL HI

a. IN THE INOR
it occurs in the m
occurs in most soi
being probably de
coprolites (so calle
the excrements of
basin.[1]
β. IN THE ORG
It forms the princi
crustaceous envel
ossified arteries,
diaphragm, and in
which is sometime
phate of lime (2Ca
concretion, also co

PREPARATION.
fixed residue *bon*
in open vessels,
white product is
usta; ossa calc
A similar pro
the deer (*Cervu*
powder, is called
igne comparata
ash is, however,
Bone ash co
carbonate and a
pre-exist in the b
the sulphur co
mentions *magne*
as constituents o
The proportio
earthy matter of

---

[1] Berzelius (*Traité*
(2CaO,PO^5), held in
[2] [Human bones co
consist of the bone ph
[3] *Phil. Trans.* for 1
[4] Dumas, *Traité de*
[5] *Chemistry of Ani*

	Ox. (Berzelius.)	*Sheep.* (Barros.)
Phosphate of Lime	85·98	80·0
Carbonate of Lime	5·77	19·3

The *Dublin College* gives the following directions for the preparation of *precipitated phosphate of lime* (*Calcis phosphas præcipitatum*, D.)

Take of Ox-bones, burned to whiteness in a clear fire, ℥iv.; Pure Muriatic Acid, f℥vj.; Distilled Water, Oij.; Solution of Ammonia, f℥xj., or as much as may be sufficient. Reduce the calcined bones to a fine powder, and digest upon this the acid, diluted with a pint of the water, until it is dissolved. To the solution, first cleared (if necessary) by filtration, add the remainder of the water, and then the solution of ammonia, until the mixture acquires an alkaline reaction, and having collected the precipitate upon a calico filter, let it be washed with boiling distilled water as long as the liquid which passes through gives rise to a precipitate when permitted to drop into a solution of nitrate of silver acidulated with nitric acid. The washed product should now be dried by exposing it for some days on porous bricks to a warm atmosphere.

By digestion with hydrochloric acid, the phosphate is dissolved, and the carbonate is decomposed, with the evolution of carbonic acid, and the formation of water and chloride of calcium. On the addition of ammonia, the phosphate is precipitated. It is washed to deprive it of all traces of chloride of calcium and hydrochlorate of ammonia.

PROPERTIES.—Triphosphate of lime is white, tasteless, odourless, insoluble in water, but soluble in nitric, hydrochloric, and acetic acids, from which solutions it is thrown down, unchanged in composition, by ammonia, potash, and their carbonates. When exposed to a very intense heat, it fuses, and undergoes no other change.

Characteristics.—It is known to be a phosphate by its solubility in hydrochloric acid, and its being again thrown down as a white precipitate when the acid solution is supersaturated with caustic ammonia. If it be digested in a mixture of sulphuric acid and alcohol, sulphate of lime is precipitated, and an alcoholic solution of phosphoric acid obtained. The acid may then be recognised by the tests for it already mentioned (see PHOSPHORIC ACID, p. 347). If the precipitated sulphate of lime be dissolved in water, the solution may be known to contain lime by the tests described for the calcareous salts.

COMPOSITION.—The composition of triphosphate of lime is as follows:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Fuchs.*	*Berzelius.*
Lime	3	84	53·84	54·35	51·68
Tribasic Phosphoric Acid	1	72	46·16	45·65	48·32
Tribasic Phosphate of Lime	1	156	100·00	100·00	100·00

According to Berzelius, the phosphate of lime of bones is composed of $8CaO,3PO^5$. But, from the observations of Fuchs and Mitscherlich, it would appear that the amount of lime has been underrated, and that the composition of the bone-phosphate is represented by the more simple formula of $3CaO,PO^5$, which, moreover, harmonises with the general constitution of the phosphates.

PHYSIOLOGICAL EFFECTS. α. *On Vegetables.*—In soils, phosphate of lime acts as an important fertiliser, as it supplies an ingredient (phosphoric acid) necessary to the growth of plants. The rapid growth of green confervæ in the deep-well water of the London Basin is ascribed by Professor Graham to the presence of phosphate of lime.

β. *On Man*
the animal struct
are essential cons
than the wants o
on which he feed
secretions. Tak
Its topical action
cultly soluble," c
then acts more or
and increases, in
blood, and the u
their difficult sol

Uses.—It has
the deposition of
advantageously c
phosphorus and
and for the prep

Administrati
tion of the Dubl
and consequently

84. CALCII

History.—Th
lime, was known,
Hollands, who ca
composition was
ascertained by Be
chloridum, L.D.,
chlorate of lime.

Natural Hist

a. In the Inorg
mineral and well wa

β. In the Orga
vegetables. Thus F

Preparation.-

The *London Colleg*

The *Edinburgh*
(commercial) and
degrees; and, when
liquid no longer red
fluid in a cold place
crystals will be obtai

The *Dublin Colleg*
Distilled Water, Ovj
be added the chalk i
add now, stirring we

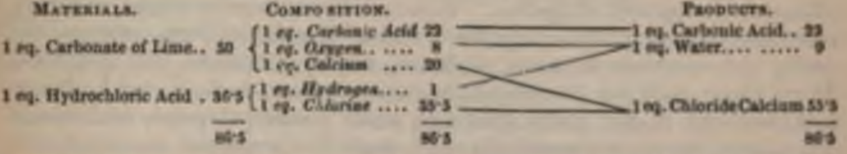
---

[1] *Die*

[2] *Die P*

the filtered solution, evaporate to dryness, and submit to a low red heat in a Hessian crucible. Finally, powder coarsely, and keep in a stoppered bottle.

In this process one equivalent of hydrochloric acid reacts on one equivalent of carbonate of lime, and produces one equivalent of carbonic acid (which escapes in a gaseous form), one equivalent of water, and one equivalent of chloride of calcium. $CaO,CO^2+HCl=CaCl+CO^2+HO$.



By heat, the crystals of this salt lose their water, and the anhydrous chloride of calcium is obtained.

Chloride of calcium is a secondary product in the manufacture of the hydrated sesquicarbonate of ammonia, as well as of solution of ammonia; and from this source it is usually procured.

PROPERTIES.—Anhydrous chloride of calcium is a white, translucent solid, of a crystalline texture. Its taste is bitter and acrid saline. It is fusible, but not volatile. It deliquesces in the air, and becomes what has been called *oil of lime* (*oleum calcis*). When put into water, it readily dissolves in a quarter of its weight of this fluid at 60° F., or in a much smaller quantity of hot water. By evaporation, the solution yields striated crystals (*hydrated chloride of calcium*), having the form of regular six-sided prisms, and which, therefore, belong to the rhombohedric system. These crystals undergo the watery fusion when heated, are deliquescent, readily dissolve in water with the production of great cold, and, when mixed with ice or snow, form a powerful frigorific mixture. Both anhydrous and hydrous chloride of calcium are readily soluble in alcohol.

Characteristics.—This salt is known to be a chloride by the tests for this class of salts, and the nature of its base is ascertained by the tests for calcareous salts.

COMPOSITION.—The composition of this salt is as follows:—

	At.	*Eq.Wt.*	*Per Ct.*	*Ure.*
Calcium	1	20	36·03	36·7
Chlorine	1	35·5	63·97	63·3
Chloride Calcium	1	55·5	100·00	100·0

	At.	*Eq. Wt.*	*Per Ct.*	*Berzel.*
Chloride Calcium............	1	55·5	50·7	50·397
Water	6	54	49·3	49·603
Crystallised Chloride Calcium	1	109·5	100·0	100·000

PURITY.—Chloride of calcium, when pure, is colourless, evolves no ammonia when mixed with lime, and undergoes no change of colour, nor gives any precipitate with caustic ammonia, chloride of barium, or hydrosulphuric acid.

The crystallised salt is "extremely deliquescent. A solution of 76 grains in one fluidounce of distilled water, precipitated by 49 grains of oxalate of ammonia, remains precipitable by more of the test."—*Ph. Ed.*

PHYSIOLOGICAL EFFECTS. α. *On Animals.*—Three drachms and a half given to a dog caused quick breathing and snorting, with convulsive but vain efforts to vomit, a profuse secretion of saliva, and death in six hours. The

mucous membra
in many places a

β. On Man.
urine, and perspi
tinued use it a
vessels and glan
dular and other
ultimately disapp
and sometimes p
pulse, and occas
In *excessive dos*
and trembling o
convulsions, para
other medicines,
barium. Hufela
substance, and th
directly opposed
titioners.

USES.—It has
those attended wi
hundred patients,
in which he has
an extensive sca
efficacious in the
purging, diminish
many cases, ultim
been recommende
chronic affections
object was to exci
it has been emplo
of it, either alone
pharmacy, fused
and ether, on acc
employed in the f
state, mixed with
duces an intense
chemical purposes

ADMINISTRATIO
form of an aqueou

LIQUOR CALCII
of Chloride of Ca
D. Dissolve and
[crystals], ℥viij.;

---

[1] Bed
[2] Vog
[3] Quo
[4] *Edi*
[5] *Op.*
[6] *Op.*
[7] Vog

Dublin solution, or gradually increased until nausea is produced. The uses of it have been above noticed.

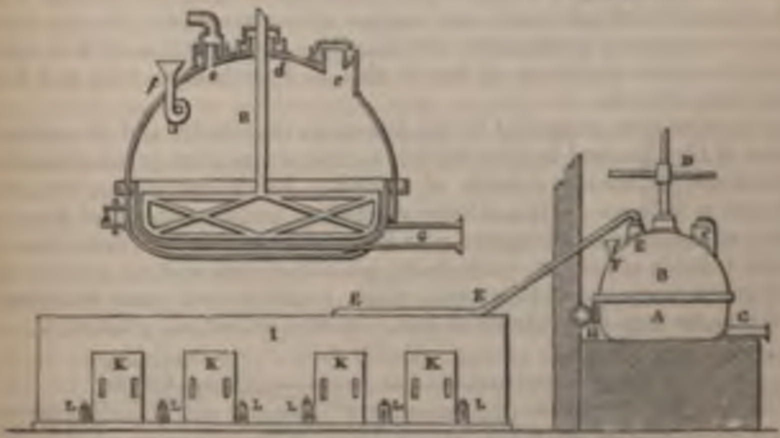
85. CALCIS HYPOCHLORIS.—HYPOCHLORITE OF LIME.

Formula CaO,ClO. *Equivalent Weight* 71·5.

HISTORY.—In 1798, Mr. Tennant, of Glasgow, took out a patent for the manufacture of a bleaching powder, which in consequence was long known by the name of *Tennant's bleaching powder.* According to the views entertained of its composition, it has been successively termed *oxymuriate of lime*, *chloride of lime*, or *chloruret of the oxide of calcium*, and *chlorinated lime* (*Calx chlorinata*, Ph. L. E. D.) It is now usually regarded as a mixture or compound of hypochlorite of lime and chloride of calcium, and its bleaching and disinfecting powers are referred to the hypochlorite or to the hypochlorous acid, which may be regarded as its active principle.

PREPARATION.—Chloride of lime is prepared on a very large scale for the use of bleachers. The chlorine gas employed in the process is usually generated in large, nearly spherical, leaden vessels heated by steam. The ingredients employed are binoxide of manganese, chloride of sodium, and diluted

FIG. 103. FIG. 102.



Apparatus for the Manufacture of Chloride of Lime.

Fig. 102.—A. Iron jacket for heating the retort by steam.
B. Leaden retort for generating chlorine.
C. Aperture for the introduction of manganese and common salt.
D. Arm of the agitator.
E. Gas discharge pipe.
F. Syphon funnel for the introduction of the sulphuric acid.
G. Discharge pipe for drawing off the residuum of the operation.
H. Steam pipe.
I. Combination chamber, divided into four compartments, each having two doors.
K, K. Doors, each having two windows.
L, L. Handles of the rakes passing through boxes.

Fig. 103.—*Section of the Retort.*
B. The agitator. The explanation of the other letters is the same as for fig. 102.

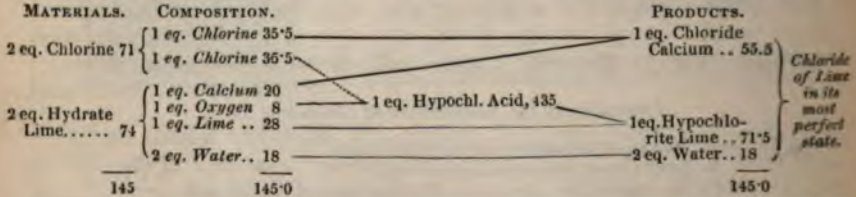
sulphuric acid (see CHLORINE). The gas is washed by passing it through water, and is then conveyed by a leaden tube into the combination room, where the slaked lime is placed in shelves or trays, piled over one another to the height of five or six feet, cross bars below each, keeping them about an inch asunder, that the gas may have free room to circulate. The combination room is built of siliceous sandstone, and is furnished with windows, to allow the operator to judge how the impregnation is going on. Four days are usually required, at the ordinary rate of working, for making good marketable chloride of lime.[1] At Mr. Tennant's manufactory at Glasgow, the lime is placed in shallow boxes on the floor of the combination chambers, and is agitated once during the process by iron rakes; the handles of which pass through boxes filled with lime, which serves as a valve.[2] The supply of chlorine is then shut off, and a man enters the chamber and rakes the lime over. The chambers are then closed, and more chlorine introduced, until the lime is saturated.[3]

At a manufactory in the neighbourhood of London, the chlorine gas is developed in stone jars, and conveyed by earthenware tubes to a stone chamber containing the hydrate of lime, which is moved by an agitator.

THEORY OF THE PROCESS.—Neither dry caustic lime nor carbonate of lime absorb chlorine gas: hydrate of lime, however, takes it up freely. Chemists are by no means agreed as to the nature of the changes which attend the process.

a. Some regard it as a compound of *chlorine, water,* and *lime.* On this view, when chlorine gas comes into contact with slaked lime, the two substances are supposed to enter into combination. An objection to this view is, that the odour of chloride of lime is that of hypochlorous acid, and not that of mere chlorine.

β. Another view, supported by the discoveries of Balard,[4] and the observations of Gay-Lussac,[5] is, that chloride of lime is a mixture or compound of hypochlorite of lime and chloride of calcium. Its formation may, then, be explained as follows:—When chlorine comes into contact with slaked lime, a portion of the latter is decomposed: its base (calcium) combines with chlorine to form chloride of calcium, while its oxygen unites with another portion of chlorine and forms hypochlorous acid, which combines with some undecomposed lime, to form hypochlorite of lime. $2CaO + 2Cl = CaCl + CaO,ClO$.



---

[1] Ure, *Quarterly Journal of Science*, xiii. 1.

[2] *American Journal of Science*, vol. x. No. 2, Feb. 1826; and Dumas' *Traité de Chimie*, ii. 806.

[3] [We find by the author's notes that, in July 1849, he visited and inspected the works of Messrs. Tennant, at Glasgow. The chlorine was there developed by the action of hydrochloric acid on the oxide of manganese, and the chloride of manganese produced was allowed to run to waste into the canal. The combination was effected without rakes. The chamber was something like that in fig. 102, marked I.—ED.]

[4] *Researches*, in Taylor's *Scientific Memoirs*, vol. i. p. 269.

[5] *Ann. Chim. et Phys.* 3me sér. t. v. p. 273.

The odour of hypochlorous acid which chloride of lime possesses strongly supports this view. On the other hand, it may be objected, that if chloride of lime contained so large a quantity of chloride of calcium, it would be deliquescent. But to this it may be replied, that the chloride of calcium may be in chemical combination with hypochlorite of lime. [The chloride of calcium in this theoretical proportion cannot be dissolved out of this compound by alcohol.—ED.]

PROPERTIES.—Chloride of lime, as met with in commerce, is a white or brownish-white powder, having a feeble odour of hypochlorous acid, and a strong bitter and acrid taste. Exposed to the air, it attracts carbonic acid, evolves hypochlorous acid, and is thereby converted into a mixture of carbonate of lime and chloride of calcium, the latter of which deliquesces. When heated, it evolves oxygen gas,[1] sometimes also chlorine gas, and becomes converted into a mixture of chloride of calcium and chlorate of lime, which has no bleaching properties. $9CaCl + 9(CaO,ClO) = 12O + 17CaCl + CaO,ClO^5$. Digested in water, the hypochlorite of lime and chloride of calcium, as well as a small portion of caustic lime, are dissolved: any carbonate, and the excess of caustic lime, remain undissolved. The solution, which has a slight yellow colour, first reacts on vegetable colours as an alkali, and afterwards bleaches them, especially if an acid be added. Carbonic acid, or a small quantity of sulphuric acid, sets free hypochlorous acid. $CaCl + CaO,ClO + SO^3 = CaCl + CaO,SO^3 + ClO$. But if a large quantity of sulphuric acid be employed, free chlorine is evolved. $CaCl + CaO,ClO + 2SO^3 = 2(CaO,SO^3) + 2Cl$.

Solution of chloride of lime decomposes—at least, when an acid is present—organic colours and putrid substances. The bleaching power on litmus is very slowly evinced unless an acid be present: carbonic acid (as by breathing through the liquid) causes the decolorisation to be speedily effected. If air be blown through putrid blood, and then through a solution of chloride of lime, carbonate of lime is precipitated, and the air is disinfected; but if air be first passed through putrid blood, then through caustic potash or milk of lime (to abstract the carbonic acid), and afterwards through a solution of chloride of lime, it retains its stinking quality. The bleaching and deodorising properties depend, probably, on the oxidisement of the colouring or offensive matter: if an excess of a strong acid be employed in the process, chlorine is evolved, which produces oxygen at the expense of the elements of water: if, on the contrary, no water is used, Balard[2] supposes that both the hypochlorous acid and lime give out their oxygen, and thereby become chloride of calcium.

The nature of the bleaching process may be illustrated by the action of chlorine and water on indigo. Indigo blue ($C^{16}H^5NO^2$), water (2HO), and chlorine (2Cl), yield by their mutual reaction isatine ($C^{16}H^5NO^4$) and hydrochloric acid (2HCl). Isatine and 2Cl yield chlorisatine ($C^{16}H^4NO^4Cl$) and HCl: isatine and 4Cl yield bichlorisatine ($C^{16}H^3NO^4Cl^2$) and 2HCl.

[Mr. W. Bastick[3] has examined the action of chlorinated lime on organic

---

[1] Henry Keller (*Pharmaceutical Journal*, vol. vii. p. 399) has proposed this as a means of obtaining oxygen gas. Half an ounce of chloride of lime, boiled in two ounces of water, yields 420 cubic centimetres [= about 165 cubic inches] of oxygen gas contaminated with chlorine. The same quantity of chloride and water, with a quarter of an ounce of binoxide of manganese, yielded, on an average, 650 cubic centimetres [= about 256 cubic inches] of oxygen.

[2] *Researches*, in Taylor's *Scientific Memoirs*, vol. i. p. 269.

[3] *Pharm. Journ.* 1848, p. 467.

compounds irresp
part of bleaching
centrated solution
tity of chloride of
the addition to th
brought about, at
the reaction, that
ducted was dashe

The results o
entirely in the ret
came over into the
the contents of t
been completely d
of the decomposit
caustic lime, and

1 eq. of Sugar.........
6 eq. Hypochl. Lime .
6 eq. Caustic Lime ...

These formulæ
bining with the f
it is necessary to
although theoretic
lime plays no part

When sugar is t
lime has been rem
water, and chloride
linen, and all the
although with gre
aggregation. In f
the proportion to
treated with hypoc

It exercises no
carbon and hydrog
it acts much in the
like body. Organ
analogous changes
some conditions no
forms a cyanogen

The chloride of
powder seems to h
of the organic bod
generally been con
lime acts as a blea
hydrogen of the org
to Mr. Bastick, pro
it possesses a highly

---

posed in virtue of this property, and that, as a general result, chlorine does not unite with any of the elements of the organic body. Even the formation of chloroform from alcohol is not altogether an exception to these rules, because three parts of the alcohol are oxidised, and only one part chlorinised. The formic acid produced was detected by nitrate of silver.—ED.]

Characteristics.—Its smell and bleaching properties are most characteristic of it. The acids (as sulphuric or hydrochloric) separate chlorine from it. An aqueous solution of it throws down white precipitates with nitrate of silver, the alkaline carbonates, and with oxalic acid or the oxalates. The supernatant liquor from which chloride of silver has been thrown down by nitrate of silver possesses a decolorising property.

COMPOSITION.—The quantity of chlorine absorbed by slaked lime varies with the pressure, the degree of exposure, and the quantity of water present. Hence the substance sold as chloride of lime is not a uniform product. The following table contains the most important results of Dr. Ure's experiments.

Prepared with Protohydrate of Lime, without pneumatic pressure. The process was carried on until the Lime ceased to absorb Chlorine.					Commercial Specimens.		
	Synthesis.	*First Analysis.*	*Second Analysis.*	*Mean.*	1.	2.	3.
Chlorine	39·39	40·00	40·62	40·31	23	22	28
Lime	46·00	44·74	46·07	45·40	46	78	71
Water	14·60	15·26	13·31	14·28	31		
Chloride of Lime	100·00	100·00	100·00	100·00	100	100	100

Good samples of commercial chloride of lime contain, on an average, not more than 36 per cent. of chlorine: and, on the small scale, hydrate of lime cannot be made to absorb more than 40 per cent. Mr. Brande[1] and Mr. Phillips[2] give the following as the atomic proportions of chlorine and hydrate of lime, in chloride of lime of the best quality:—

	Atoms.	*Eq. Wt.*	*Per Cent.*
Chlorine	1	35·5	32·42
Hydrate of Lime	2	74	67·58
Chloride of Lime	1	109·5	100·00

	Atoms.	*Eq. Wt.*
Bihydrated Chloride of Lime	1	81·5
Lime	1	28
Chloride of Lime (Phillips)	1	109·5

"When water is added to this, the chloride of lime dissolves, leaving nearly all the lime insoluble." (Phillips.)

If, with Berzelius and Balard, we regard bleaching powder as constituted of hypochlorite of lime, chloride of calcium, and water, its composition, corresponding with the proportions assumed by Mr. Brande and Mr. Phillips, will be as follows:—

	At.	*Eq. Wt.*	*Per Ct.*
Hypochlorite of Lime	1	71·5	32·65
Lime	2	56	25·57
Chloride of Calcium	1	55·5	25·34
Water	4	36	16·44
Commercial Bleaching Powder	1	219·0	100·00

or

	At.	*Eq. Wt.*	*Per Ct.*
Trihypochlorite of Lime	1	127·5	58·22
Chloride of Calcium	1	55·5	25·34
Water	4	36·0	16·44
Commercial Bleaching Powder	1	219·0	100·00

---

[1] *Manual of Chemistry*, p. 642, 1848.

[2] *Translation of the Pharmacopœia.*

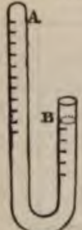
When bleaching powder is digested in water, a bleaching liquor is obtained, while a portion of lime remains undissolved. The trishypochlorite is supposed to be decomposed by the action of water, and to deposit two equivalents of lime, while one equivalent of chloride of calcium, and one equivalent of neutral hypochlorite of lime, are dissolved.

If the hydrate of lime be diffused through water, it will then absorb more than its own weight of chlorine, and form a solution containing 1 equivalent of lime (or of hydrate of lime) and 1 of chlorine, which is the true atomic compound, and is dissolved out of bleaching powder by water (Brande).

	Atoms.	*Eq.Wt.*	*Per Ct.*			*Atoms.*	*Eq.Wt.*	*Per Ct.*
Lime	1	28	38·6		Hypochlorite of Lime	1	71·5	49·3
Water	1	9	12·4		Chloride of Calcium	1	55·5	38·3
Chlorine	1	35·5	49·0	or	Water	2	18	12·4
	1	72·5	100·0			1	145·0	100·0

Chlorometry.—In order to estimate the bleaching power of the chloride of lime of commerce, various chlorometrical methods have been devised. One method is to determine the quantity of chlorine gas which is given out by a certain weight of chloride on the addition of liquid hydrochloric acid.[1] The liquid may be brought into contact with the chloride placed over mercury, contained in a graduated syphon-tube, closed at one end (fig. 104, B). When the gas is evolved, the mercury flows out, by the orifice B, into a basin ready to receive it. The resulting film of chloride of calcium protects the surface of the metal from the action of the chlorine. If carbonic acid be suspected, the mercury by agitation absorbs the chlorine, leaving the carbonic acid. Ten grains of bleaching powder yield from three to four cubic inches of chlorine, equivalent to twenty or thirty per cent. by weight.

Fig. 104.



Syphon tube for chlorometrical purposes.

Another chlorometrical method is to ascertain the bleaching power of the chloride on a standard solution of indigo;[2] but it is not susceptible of accuracy.

A chlorometrical method, which Professor Graham[3] considers "to be entitled to preference," is founded on the fact that chloride of lime converts sulphate of the protoxide of iron into sulphate of the peroxide. Red ferroprussiate of potash (*ferridcyanide of potassium, ante*, p. 534,) is employed to ascertain the change in the degree of the oxidation of the iron, since it gives a blue precipitate with the protosalts, but not with the persalts of this metal. A quantity of solution of chloride of lime, capable of peroxidising 78 grains of sulphate of iron, contains 10 grains of chlorine. Gay Lussac has proposed a chlorometrical method, founded on the conversion of arsenious into arsenic acid by chlorine. Dissolve 100 grs. of arsenious acid in 2000 of strong hydrochloric acid, and dilute with distilled water till the liquid occupies the volume of 7000 grs. of water (=℥xvj.) This is the standard test-liquor. Diffuse 100 grs. of bleaching powder through 1000 grs. of water, and gently pour over it the test-liquor until the liquid acquires the power of bleaching a drop of a solution of sulphate of indigo; that is, until free chlorine is present. The quantity of chlorine in the bleaching powder is equal to $\frac{1}{100}$th part of the quantity of the test-liquor employed. Thus if 3000 grains of the test-liquor be employed, the quantity of chlorine in the bleaching powder is 30.

---

[1] Ure, *Quarterly Journal of Science*, vol. xiii.

[2] Gay-Lussac, *Ann. of Phil.* xxix. 218; also in Alcock's *Essay*, before quoted, p. 135.

[3] *Elements of Chemistry*, p. 502.

The *Edinburgh College* gives the following characteristics of good chloride of lime:—

> "Pale greyish-white: dry: 50 grains are nearly all soluble in two fluidounces of water, forming a solution of the density of 1027, and of which 100 measures, treated with an excess of oxalic acid, give off much chlorine, and if then boiled and allowed to rest twenty-four hours, yield a white precipitate which occupies nineteen measures of the liquid."

The precipitate produced in the solution by oxalic acid is oxalate of lime, and, therefore, this process is one for the detection of lime (or oxide of calcium).

The *London College* merely observes that chlorinated lime—

> "Dissolves in dilute hydrochloric acid, emitting chlorine."

Neither College, therefore, gives directions for estimating the real value of chloride of lime.

PHYSIOLOGICAL EFFECTS.—Chloride of lime may be regarded practically as a compound of hypochlorite of lime, chloride of calcium, and hydrate of lime; and its effects are those of the substances now enumerated (see *calx, ante*, p. 616); and *calcii chloridum, ante*, p. 630). The effects for which it is employed in medicine are those of the hypochlorite.

The *local* action of chloride of lime is that of an irritant and caustic. A solution of it applied to suppurating and mucous surfaces is a powerful desiccant, probably in part at least from the uncombined lime in solution. When the secretions are excessive and extremely fetid, it not only diminishes their quantity, but much improves their quality; so that, considered in reference to suppurating and mucous surfaces, it is not only a desiccant, but, in morbid conditions of these parts, a promoter of healthy action. Applied in the form of ointment (composed of a drachm of chloride to an ounce of fatty matter) to scrofulous swellings, Cima[1] found that it provoked suppuration, caused strong redness, promoted the suppurating process, and dispersed the surrounding hardness.

Taken *internally*, in *small doses* (as from 3 to 6 grains, dissolved in one or two ounces of water), it sometimes causes pain and heat in the stomach, and occasionally, according to Cima, purging. Under the continued use of it, hard and enlarged absorbent glands have become softer and smaller, from which circumstance it has been supposed to exercise a specific influence over, and to promote the healthy action of, the lymphatic system. During its employment, Cima says he did not find it necessary to give purgatives. Dr. Reid[2] gave it in the epidemic fever which raged in Ireland in 1826, and he tells us that it rendered the tongue cleaner, abated the delirium, and promoted the cutaneous functions. In dysentery, it soon put a stop to the bloody evacuations, the umbilical pain, and the tenesmus.

---

[1] Configliachi and Brugnatelli's *Giornale di Fisica*, 1825; quoted by Dierbach, *D. neust. Entd. in d. Mat. Med.* 1828, 2te Abt. 597.

[2] *Trans. of the Associat. of Fellows and Licentiates of the College of Physicians in Ireland*, vol. v. 1828.

I am not acquainted with any facts respecting the effects of chloride of lime in large or *poisonous doses*. Analogy would lead us to expect that it would produce the combined effects of a caustic and of an agent specifically affecting the nervous system.

Uses.—The chlorides (hypochlorites) of lime and soda are extensively employed as disinfectants (or rather deodorisers) and antiseptics. It has been already stated that chlorine gas stands unrivalled for its power of destroying putrid odours and checking putrefaction, and where uninhabited chambers or buildings are to be purified, fumigations with this gas should be adopted. But its powerful action on the organs of respiration precludes its use in inhabited places; and, in such cases, the alkaline chlorides (chloride of lime, on account of its cheapness) may be substituted. When these substances are in contact with organic mattter, it is supposed the hypochlorite gives out oxygen, and is converted into a metallic chloride; the oxygen being the effective deodorising and antiseptic agent; or it may act by abstracting hydrogen. When, however, the solution of the hypochlorite is exposed to the air, carbonic acid is abstracted by the lime, and hypochlorous acid immediately reacts on any organic matter present. Hence these hypochlorites, when exposed to the air, evolve chlorine so slowly, and in such moderate quantities, as not to produce any noxious effects, although their action on organic matters is very powerful. Their most obvious effect is that of destroying the unpleasant odour of putrid matter. Their action on hydrosulphuric acid, ammonia, and hydrosulphate of ammonia (substances evolved by decomposing animal matters) can be readily and easily demonstrated. Other odorous principles given out by putrid matters are, by the experience of most persons, admitted to be destroyed by the alkaline hypochlorites, though Piorry[2] has asserted they are only overpowered by the stronger smell of chlorine. The alkaline hypochlorites possess another valuable property—that of stopping or checking the putrefactive process; and hence they are called antiseptics.[3]

These two properties—viz. that of destroying offensive odours and that of preventing putrefaction—render the alkaline hypochlorites most valuable agents to the medical practitioner. We apply them to gangrenous parts, to ulcers of all kinds attended with foul secretions, to compound fractures accompanied with offensive discharges, to the uterus in various diseases of this viscus attended with fetid evacuations: in a word, we apply them in all cases accompanied with offensive and fetid odours. As I have already remarked, with regard to hypochlorite of soda, their efficacy is not confined to an action on dead parts, or on the discharges from wounds and ulcers; they are of the greatest benefit to living parts, in which they induce more healthy [illegible] and the consequent secretion of less offensive matters. Furthermore, in the sick chamber, many other occasions present themselves on which the [illegible] of the hypochlorites to destroy offensive odours will be found of the [illegible] value; as, to counteract the unpleasant smell of dressings or bandages, [illegible] in various diseases of the bladder, and of the alvine evacuations. [illegible] a handkerchief, or piece of calico, dipped in a weak solution of an alkaline hypochlorite, and suspended in the sick chamber, will be often of considerable service both to the patient and the attendants.

---

[2] [illegible] Méd. ii. 601.

[3] [illegible] proof of this, I must refer to the late Mr. Alcock's *Essay on the Use of the* [illegible] 1827.

The power of the hypochlorites to destroy *infection* or *contagion*, and to prevent the propagation of epidemic diseases, is less obviously and satisfactorily ascertained than their capability of destroying *odour*. Various statements have been made by Labarraque and others[1] in order to prove the disinfecting power of the hypochlorites with respect to typhus and other infectious fevers. But, without denying the utility of these agents in destroying bad smells in the sick chamber, and in promoting the recovery of the patient by their influence over the general system, I may observe that I have met with no facts which are satisfactory to my mind as to the chemical powers of the hypochlorites to destroy the infectious matter of fever. Nor am I convinced by the experiments made by Pariset and his colleagues,[2] that these medicines are preservative against the plague. Six individuals clothed themselves with impunity in the garments of men who had died of the plague, but which garments had been plunged for six hours in a solution of chloride of soda. But, as Bouillaud[3] has truly observed, the experiments, to be decisive, should have been made with clothing which had already communicated the plague to the wearers of it. Bousquet[4] mixed equal parts of a solution of chloride of soda and the vaccine lymph, and found that the latter still possessed the power of producing the usual cow-pock vesicle. These are a few of the facts which are adverse to the opinion that the alkaline hypochlorites possess the power of preventing the propagation of infectious, contagious, or epidemic diseases. In opposition to them there are but few positive facts to be adduced. Coster[5] found that a solution of hypochlorite of soda destroyed the infectious properties of the syphilitic poison, and of the poison of rabid animals. The statements of Labarraque[6] and others as to the preservative powers of the hypochlorites in typhus, measles, and other zymotic diseases, are too loose and general to enable us to attach much value to them.

Considered in reference to medical police, the power of the alkaline hypochlorites to destroy putrid odours and prevent putrefaction is of vast importance. Thus chloride of lime may be employed to prevent the putrefaction of corpses previously to interment, to destroy the odour of exhumed bodies during medico-legal investigations, to destroy bad smells, and prevent putrefaction in dissecting-rooms and workshops in which animal substances are employed (as cat-gut manufactories), to destroy the unpleasant odour from privies, sewers, drains, wells, docks, &c., to disinfect (?) ships, hospitals, prisons, and stables. The various modes of applying it will readily suggest themselves. For disinfecting corpses, a sheet should be soaked in a pailful of water containing a pound of chloride, and then wrapped around the body. For destroying the smell of dissecting-rooms, a solution of the chloride may be applied by means of a garden watering-pot. When it is considered desirable to cause the rapid evolution of chlorine gas, hydrochloric acid may be added to chloride of lime.

Hypochlorite of lime (or of soda) is the best *antidote* in poisoning by hydrosulphuric acid, hydrosulphuret of ammonia, sulphuret of potassium, and hydrocyanic acid. It decomposes and renders them inert. A solution should be administered by the stomach, and a sponge or handkerchief soaked in the solution, held near the nose, so that the vapour may be inspired. It was by breathing air impregnated with the vapour arising from chloride of lime, that the late Mr. Roberts (the inventor of the miner's improved safety lamp) was enabled to enter and traverse with safety the sewer of the Bastile, which had not been cleansed for 37 years, and which was impregnated with hydrosulphuric acid.[1] If a person be required to enter a place suspected of containing hydrosulphuric acid, a handkerchief moistened with a solution of chloride of lime should be applied to the mouth and nostrils, so that the inspired air may be purified before it passes into the lungs.

---

[1] Vide Alcock's *Essay*, p. 155, *et seq.*

[2] *Bullet. des Sciences Méd.* xix. 233.

[3] *Dict. de Méd. Prat.* art. *Contagion.*

[4] *Rev. Méd.* Fév. 1830, p. 264.

[5] Richter, *Ausf. Arzneimittell.* Suppl. Band, 539.

[6] Alcock's *Essay*, pp. 56, 58, &c.

A solution of chloride of lime has been used as a wash in some skin diseases. Derheims[2] used a strong solution with great success in scabies. This mode of curing itch is much cleaner and more agreeable than the ordinary method by sulphur frictions. It has likewise been found successful by Fantonetti[3] in tinea capitis: when the discharge is copious, washes of the chloride may be used with advantage. In burns and scalds, Lisfranc employed lotions of chloride of lime either immediately after the accident, or subsequently to the application of emollient poultices.

Solutions of chloride of lime have been employed with great benefit in ophthalmia. Dr. Varlez, surgeon to the military hospital at Brussels,[4] states, that in 400 cases it never disappointed him once. Mr. Guthrie has also reported favourably of it in three cases; as have likewise MM. Colson, Delatte, and Raynaud. The solution used by Dr. Varlez was composed of from a scruple to three or four drachms of chloride, and an ounce of water. It was dropped into the eye, or injected by a syringe, or applied by means of a camel's hair pencil. I have found a weak solution of the chloride successful in the purulent ophthalmia of infants. Gubian[5] proposed to apply a solution of chloride of lime to prevent the pitting from small-pox. The fully maturated pustules are to be opened and washed with a weak solution of this salt: desiccation takes place very promptly, and no marks or pits are said to be left behind.

[In the Report of the Registrar-General for Aug. 26, 1854, there is a singular case recorded, in which an infant of four months is alleged to have died from the effects of chloride of lime locally applied. The Registrar states, that "in this case an unusual quantity of chloride of lime for the cleaning of bed furniture was placed in a copper used for washing, when the mother of deceased, unconscious of its effects, put therein the linen napkins of her child, which, when they were applied to the infant, and had become moist, produced the consequences above described." The cause of death was assigned to be "ulceration of the skin produced by chloride of lime accidentally applied." In this case it is probable that the lime was the principal ingredient in causing injury to the skin.—Ed.]

Chloride of lime may be employed *internally* in the same cases that chloride of soda is administered. It has been used with great success by Dr. Reid[1] in the epidemic fever of Ireland. In some of the very worst cases it acted most beneficially, causing warm perspiration, rendering the tongue cleaner and moister, checking diarrhœa, and inducing quiet sleep. I also can bear testimony to the good effects of it in bad cases of fever. In disease of the pulmonary organs, resulting from febrile excitement, Dr. Reid also found it advantageous. In dysentery likewise it was most valuable. He used it by the mouth, and also in the form of clyster. It corrected the intolerable stench of the evacuations, and improved their appearance. Cima[2] used it both internally and externally in scrofula.

---

[1] Alcock's *Essay*.
[2] *Journ de Chim. Méd.* iii. 575.
[3] *Ibid.* ix. 305.
[4] *Med. and Phys. Journ.* Nov. 1827.
[5] *Journ. de Chim. Méd.* vi. 315.

ADMINISTRATION.—*Internally*, chloride of lime may be given in doses of from one grain to five or six grains, dissolved in one or two ounces of water, sweetened with syrup. As the dry chloride of the shops deposits hydrate of lime when put into water, the solution (of the hypochlorite of lime and chloride of calcium) should be filtered, to get rid of this.

ANTIDOTES.—Administer albuminous liquids (as eggs beat up with water) or milk, or flour and water, or oil, or mucilaginous drinks, and excite vomiting; combat the gastro-enteritis by the usual means. Carefully avoid the use of acids, which would cause the evolution of chlorine gas in the stomach.

1. CALCIS CHLORINATÆ LIQUOR, D.; *Chloride of Lime Liquor.*—Take of Chlorinated Lime, lb. ss.; Water, *Cong.* ss. Blend well the water and chlorinated lime by trituration in a large mortar, and having transferred the mixture to a well-stoppered bottle, let it be well shaken several times for the space of three hours. Pour out now the contents of the bottle on a calico filter, and let the solution which passes through be preserved in a well-stoppered bottle. The specific gravity of this liquid is 1035.

2. LOTIO CALCIS CHLORINATÆ; *Chloride of Lime Lotion.* (Chloride of Lime, ʒj. to ʒiv.; Water, Oj. Triturate and filter.)—Applied to foul ulcers and wounds. For the cure of itch, Derheims employed a wash composed of chloride of lime, ℥j., water, Oj.[3]

3. GARGARISMA CALCIS CHLORINATÆ; *Chloride of Lime Gargle.* (Chloride of Lime, ʒij.; Water, Oj. Triturate and filter; then add Honey, ℥j.)—Used in ulceration of the mouth and throat. *A disinfecting mouth-wash* has been before described (see *ante*, p. 159).

4. DENTIFRICIUM CALCIS CHLORINATÆ; *Chloride of Lime Dentifrice; Deodorising and Decolorising Dentifrice.* (Chloride of Lime, ʒj.; Precipitated Chalk, ʒxx. M.)—Used to destroy the unpleasant odour of the breath, and to restore the whiteness of the teeth, especially when stained by tobacco. A drop or two of otto of roses or oil of neroli may be advantageously added to the above.

5. ENEMA CALCIS CHLORINATÆ; *Chloride of Lime Clyster.* (Add

---

[1] *Transactions of the King and Queen's College of Physicians in Ireland*, v. 266.

[2] Richter, *Ausf. Arzneimitt.* iv. 305.

[3] [M. Fleury has also employed this lotion with success in the treatment of itch. See *Bulletin Thérapeutique Méd.* t. xxxv. p. 280.—ED.]

Chloride of Lim
deodoriser when

6. UNGUENTU
(Chloride of Lim
as an application

7. TROCHISC
(Chloride of Lim

ORDER

Magnesium,
basis of magnesia
but is more rarel

HISTORY.—It
Black, who also s
From its composi
the British Pharn
procuring it, it is
calcinata seu *ust*
earth (*Bittererd*
NATURAL HIST

α. IN THE INORGA
solution, in sea or
(carbonic, sulphuric,
water, as also in son
β. IN THE ORGAN
(as *Salsola Kali* an
calculi of man).

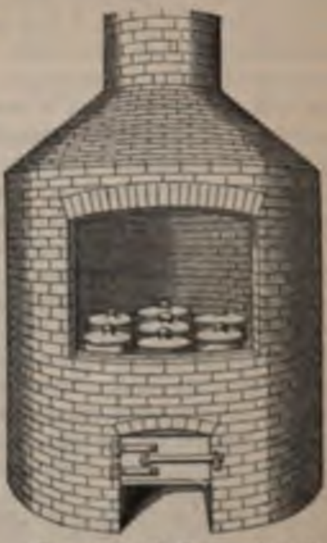
PREPARATION.–
magnesia to heat,

The *Edinburgh C*
convenient quantity
for two hours, or till t
the addition of muria
The directions of t

The operation
placed in a furnace
(see fig. 105).

In this process the hydrated carbonate of magnesia is deprived of its water and carbonic acid, and loses in consequence about 58 per cent. in weight. If the heat be insufficient, or applied for too short a period, only a portion of carbonate is left undecomposed; but if, on the other hand, the heat be raised to whiteness, the preparation is apt to be lumpy. If the carbonate employed contain lime, the flavour of the calcined magnesia is impaired; and if it contain iron, a reddish or foxy tint is communicated to the product. The iron is usually derived from the sulphate employed in the preparation of the magnesian carbonate. It may be got rid of by adding to the solution of the sulphate, a sufficiency of lime water to enable it to restore the blue colour of reddened litmus, and letting it stand for the oxide of iron to subside. Care must of course be taken to prevent soot, cinders, or other impurities, falling into the crucible. After its calcination, the magnesia is usually passed through a fine sieve.

FIG. 105.



Furnace for the Preparation of Calcined Magnesia.

To obtain the ***heavy calcined magnesia*** (***magnesia calcinata ponderosa***), the following formula has been given by Mr. R. Phillips, junior.[1] Dissolve 123 parts of crystallised sulphate of magnesia in boiling water. Dissolve 144 parts of crystallised carbonate of soda in boiling water. Mix the two solutions, and evaporate the mixture to dryness. Calcine the dry residue in a crucible for two hours, or until the whole of the carbonic acid is expelled; then treat the powder which remains with water until the whole of the soluble salt is removed, and dry the residue. The magnesia thus obtained will be much more dense than that prepared by the preceding processes.

PROPERTIES.—It is a light, fine, white, colourless, odourless, and tasteless powder. Its density varies according to the mode of preparing it. Mr. Kirwan says it is 2·3; Richter, 3·07; and Karsten, 3·2. When moistened with water it reacts as an alkali on test papers. It is very slightly soluble in water, and, like lime, is more soluble in cold than in hot water. Dr. Fyffe states that it requires 5142 parts of cold, and 36000 parts of hot water to dissolve it. Unlike lime it evolves scarcely any heat when mixed with water. By the combined voltaic and oxy-hydrogen flames it has been fused by Mr. Brande.[2] It absorbs carbonic acid slowly from the atmosphere.

Two kinds of calcined magnesia are known and kept in the shops,—one simply called ***calcined magnesia***, but which, for the sake of distinction, I shall call ***common calcined magnesia***, and the other distinguished as

---

[1] *Pharmaceutical Journal*, vol. iii. p. 480, 1844.

[2] *Manual of Chemistry*.

heavy calcined
magnesia, sold
1. *Common*
much lighter p
the samples of it
and effervesce w
examined by the
and is found to
mixed with frag
in the light carb
The crystals are
position during
2. *Heavy Ca*
is sometimes call
purer, and heavi
samples which I
calcined magnesi
water and acetic
the naked eye,
masses formed
hardness to prod
label of one speci
one part in bulk
When moistened,
calcined magnesi
or less cohering i
in it (see fig. 107)
samples of heavy

FIG.

Microscopic Appea
Calcined M

Characteristic
vescence. The
cipitate with the
but the neutral
throw down a w
with phosphate of
magnesia). Ma

distinguished from alumina. Its solution in sulphuric acid is remarkable for its great bitterness.

COMPOSITION.—Magnesia has the following composition:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Wollaston.*	*Gay-Lussac.*	*Berzelius.*
Magnesium	1	12	60	59·3	59·5	61·29
Oxygen	1	8	40	40·7	40·5	38·71
Magnesia	1	20	100	100·0	100·0	100·00

PURITY.—When it has been subjected to an insufficient heat during its preparation, or when it has been exposed for some time to the air, it will be found to contain some carbonate of magnesia. Its freedom from carbonate is shown by its dissolving in dilute mineral acids without effervescence. [It should dissolve in diluted sulphuric acid by heat, without leaving any residue. —ED.] If the carbonate from which it has been prepared has been insufficiently washed, the calcined magnesia may contain traces of sulphate or hydrochlorate of soda or potash. By boiling it in distilled water, and testing the solution with chloride of barium and nitrate of silver, the absence or presence of sulphuric or hydrochloric acid (or chlorine) may be ascertained. Its hydrochloric solution should occasion no precipitate with the oxalates, bicarbonates, and barytic salts, by which the absence of lime and sulphates may be inferred.

When moistened with water it slightly changes the colour of turmeric to brown. It dissolves in hydrochloric acid without effervescence. Neither bicarbonate of potash nor chloride of barium throws down anything from the solution.—*Ph. Lond.*

"Fifty grains are entirely soluble without effervescence, in a fluidounce of [pure] muriatic acid: an excess of ammonia occasions in the solution only a scanty precipitate of alumina: the filtered fluid is not precipitated by solution of oxalate of ammonia."—*Ph. Ed.*

The quantity of hydrochloric acid directed to be used by the Edinburgh College is unnecessarily large.

PHYSIOLOGICAL EFFECTS.—When taken into the stomach, magnesia neutralises the free acids contained in this organ and in the intestines, and forms therewith soluble magnesian salts. In full doses it acts as a laxative; but as it occasions very little serous discharge, Dr. Paris[1] ranks it among purgatives "which urge the bowels to evacuate their contents by an imperceptible action upon the muscular fibres." Part of its laxative effect probably depends on the action of the soluble magnesian salts which it forms by union with the acids of the alimentary canal. Magnesia exercises an influence over the urine analogous to that of the alkalies: that is, it diminishes the quantity of uric acid in the urine, and when continued for too long a period occasions the deposit of the earthy phosphates in the form of white sand.[2] On account of its great insolubility, it requires a longer time to produce these effects than the alkalies. When taken in too large quantities and for a long period it has sometimes accumulated in the bowels to an enormous extent, and being concreted by the mucus of the bowels, has created unpleasant effects. A lady took every night during two years and a half, from one to two tea-spoonfuls of Henry's calcined magnesia (in all between 9 and 10 lbs. troy) for a nephritic attack, accompanied with the passage of gravel; subsequently she became

---

[1] *Pharmacologia*, vol. i. art. *Cathartics*.

[2] W. T. Brande, *Phil. Trans.* 1810, p. 136; and 1813, p. 213.

sensible of a ten
deep-seated tum
constipation wit
highly irritable s
two pints of "s
which were foun
the mucus of th
a mass of a simil
in the head of t
any magnesia.[1]

USES.—As an
advantage over t
apt to occasion
neutralise acids
poisoning by the
to neutralise wh
ministered to rel
of an abnormal
persons of a gou
of uric acid. It
unfrequently sub
uric acid in the
W. T. Brande[2] it
will be found of
remedies are indi
symptoms. It is
especially in that
doses of from a s

As a *laxative,*
of children. It
which render it
these, Hufeland a
tinal irritation by
with some carmin
is employed as a
rectum, as piles a
carminative waters
crease its cathartic
with a solution of
of iron, it is servi
—ED.]

ADMINISTRATIO
to a drachm; for
is from ten to thi
milk.

---

[1] E. Brande, *Quarter*
[2] *Phil. Trans.* 1813,
[3] Dr. Watson, in the

87. MAGNESIÆ CARBONATES.—CARBONATES OF MAGNESIA.

Eight compounds of magnesia and carbonic acid have been described : they are as follows :—

			Formulæ.
Subcarbonates	⅔ carbonate terhydrated		$3MgO,2CO^2,3HO$
	¾ carbonate (*hydromagnesite*)		$4MgO,3CO^2,4HO$
	⅘ carbonate	pentahydrated	$5MgO,4CO^2,5HO$
		hexahydrated (*magnesia alba*)	$5MgO,4CO^2,6HO$
Neutral or Mono-carbonates	anhydrous (*magnesite*)		MgO,CO^2
	terhydrated		$MgO,CO^2,3HO$
	pentahydrated		$MgO,CO^2,5HO$
Bicarbonate			$MgO,2CO^2$

The formation of several of these compounds appears to be determined by the relative proportions of the precipitants, the temperature of the solutions, and the temperature of desiccation. Two only are employed in medicine—namely, the compound called ***carbonate*** or ***subcarbonate of magnesia***, or ***magnesia alba***, and the ***bicarbonate***.

1. Magnesiæ Subcarbonas Hydrata.—Hydrated Subcarbonate of Magnesia.

Formula $5MgO,4CO^2,6HO$; or $4(MgO,HO,CO^2)+MgO,2HO$. *Equivalent Weight* 242.

HISTORY.—Carbonate of magnesia (***magnesiæ carbonas***, L. E. D.), also called ***magnesia alba*** and ***subcarbonate of magnesia*** (***magnesiæ subcarbonas***), was exposed for sale at Rome, at the commencement of the 18th century, by Count di Palma, in consequence of which it was termed *Comitissæ Palmæ pulvis*. In 1707, Valentini informed the public how it might be prepared. It is a compound of magnesia, carbonic acid, and water, and, therefore, has been denominated ***magnesia hydrico-carbonica*** in the Prussian Pharmacopœia, and ***carbonas magnesicus cum aquâ*** in the French Codex. In the Hamburgh Codex, the terms ***magnesia anglica*** and ***magnesia salis amari*** are given as synonymes of this substance.

NATURAL HISTORY.—Native, anhydrous, neutral carbonate of magnesia (MgO,CO^2), called ***magnesite***, is found in various parts of Europe, Asia, and America. The mineral called ***hydromagnesite*** is, according to L. Gmelin, a quadro-hydrate of the ¾ carbonate of magnesia, $4MgO,3CO^2,4HO$; or a compound of hydrate of magnesia and the hydrated carbonate, $MgO,HO+3(MgO,CO^2,HO)$. It accompanies magnesite in India and in America. Carbonate of magnesia, in conjunction with carbonate of lime, occurs in some mineral waters.

Magnesite constitutes a range of low hills in Hindostan. Some years ago a cargo of it was brought over by Mr. Babington. Dr. Henry[1] analysed a sample of it, and found its constituents to be *magnesia*, 46; *carbonic acid*, 51; *insoluble matter*, 1·5; *water*, 0·5; and *loss*, 1 = 100. Native carbonate of magnesia, from India, has been imported in considerable quantities into this country; but has been found, as I am informed, unsaleable here. The samples offered for sale in the year 1837 consisted of reniform, opaque, dull masses, adherent to the tongue, having a conchoidal fracture and considerable hardness. Inter-

---

[1] *Annals of Philosophy*, N. S. vol. i. p. 252.

nally, they were
(I presume) was b
Indian calcined ma

PREPARATION.
of carbonate of

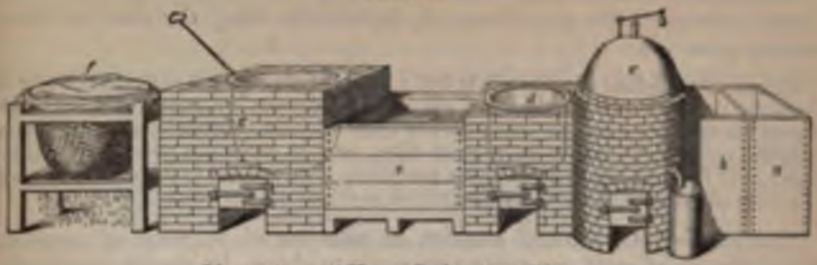
The *London Coll*
and ℥ix.; Distille
sulphate of magn
liquors, stirring co
poured off, wash th
The *Edinburgh*
of using an ounce l
tion of this compou
The *Dublin Colle*
commerce, ℥x.; Cr
sufficient quantity.
cold, and boil the
pour upon it repeat
a solution of nitrat

Should the su
water (see *calci*
Two kinds of
the *light* and th
a. Light car
factured in the
Scotch magnes
(*bittern*) of sea-
of magnesia in
ing to Durand,[1]
of 100 parts of
heated by steam
soda is quickly
expel carbonic
liquor is then de
subsidence and d
is then transferre
hours, and is tra
placed upon a ta
water: after a ti
upper side of th
mately completed
β. Heavy ca
(*magnesiæ carbo*
I have seen follo
cold saturated so
of a saturated sol
Boil until efferves
dilute with boilin
the precipitate wi
an iron pot.

---

[1]

FIG. 108.



Manufactory of Heavy Carbonate of Magnesia.

a. Cistern containing the solution of the Sulphate of Magnesia.
b. Ditto containing solution of Carbonate of Soda.
c. Boiler for supplying hot water.
d. Ditto for the mixed solutions.
e. A back in which the Carbonate of Magnesia is deposited.
f. Filter (linen cloth supported in a basket, contained in a wooden stand).
g. Iron pot for drying the Carbonate of Magnesia.

Mr. Richard Phillips, jun.[1] gives the following directions for procuring the heavy carbonate of magnesia:—Mix a solution of 123 parts of crystallised sulphate of magnesia with a solution of 144 parts of crystallised carbonate of soda, and boil to dryness. Then treat the residue with water until all the soluble matter (sulphate of soda) is removed, and dry the residual powder.

A heavy carbonate of magnesia has been prepared by Mr. Pattinson, an extensive chemical manufacturer of Gateshead, from the magnesian limestone of Durham.[2] The limestone is calcined in close iron vessels at a dull red heat: by this means the magnesian carbonate only is decomposed, the carbonate of lime requiring a higher temperature for its decomposition. The calcined mass is next placed in a strong closed iron vessel, along with a large quantity of water, and the carbonic acid resulting from the calcination is forced into it by a powerful pump in the usual manner. By this means the magnesia only is dissolved, so long as the magnesia is in excess. The saturated solution, containing fifteen grains in the fluidounce, is drawn off and boiled down, by which carbonic acid is set free, and a heavy carbonate of magnesia obtained. It has been analysed by Mr. Fownes,[3] who finds it to be completely free from lime, and to be identical in composition with the common carbonate of magnesia of the shops. A *heavy* and *gritty carbonate of magnesia* is prepared by separately dissolving twelve parts of sulphate of magnesia and thirteen parts of crystallised carbonate of soda in as small a quantity of water as possible, mixing the hot solutions, and washing the precipitate. When cold solutions of sulphate of magnesia and carbonate of soda are mixed, and no heat is employed, the product is apt to be gritty; that is, crystalline. According to Professor Graham,[4] carbonate of soda is not so suitable as carbonate of potash for precipitating magnesia, "as a portion of it is apt to go down in combination with the magnesian carbonate; but it may be used, provided the quantity applied be less than is required to decompose the whole magnesian salt in solution."

---

[1] *Pharmaceutical Journal*, vol. iii. p. 480, 1844.

[2] Mr. Morson, in the *Pharmaceutical Journal*, vol. iii. p. 424, 1844.

[3] *Pharmaceutical Journal*, vol. iii. p. 478, 1844.

[4] *Elements of Chemistry*, p. 505.

The *Dublin Co*
heavy carbonate,
already given :—

Dissolve the sulpha
the water; mix the t
Digest the residue for
collected the insolubl
water until the washi
of nitrate of barytes.

THEORY.—By th
and carbonate of s
tion, sulphate of s
$MgO,CO^2 + NaO,S$

MATERIALS.

1 eq. Sulphate Magnesia 6

1 eq. Carbonate Soda .. 5

11

It appears, howe
magnesia, and resol
bicarbonate, which
part of its carbonat

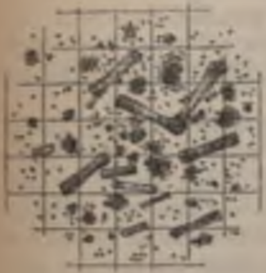
Three circumstance
magnesia), viz., the pr
and their temperature.
is dense, retains a port
of magnesia be empl
phuric or hydrochloric
of sulphate of magne
more dilute the solutio
tions are employed, an
bicarbonate of magnes
is the lightest.

PROPERTIES.—C
of a white, inodoro
variety occurs in co
lightly fill an ounce
with levelled edges,
squares). The lig
copious draught, is
imperfectly washed.
specific gravity than
so that it would ap
light carbonate. It
have a feebly alkali
insoluble in water:
mens of *light* carbo
I have met with, pr

the microscope. They usually consist of an amorphous powder more or less intermixed with slender prisms, which appear as if they were eroded or efflorescent (see fig. 110). These crystals resemble in shape those of the neutral carbonate of magnesia deposited from Dinneford's carbonated magnesia water (see fig. 112, p. 654).

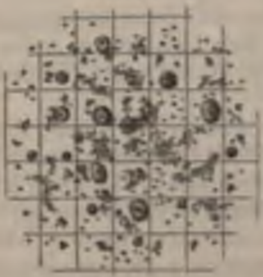
The *heavy* carbonate of magnesia is a granular substance, and contains no traces of the prismatic crystals observed in the light carbonate. When submitted to microscopic investigation, it is seen to consist of granules of various sizes: the larger ones are highly refracting, globular, and composed of concentrated layers of a radiated structure (see fig. 110). When examined by the polarising microscope, they are found to possess a double refracting structure; and, like the globules of carbonate of lime deposited from the urine of horses[1] and bullocks,[2] show the black cross (see fig. 111). When placed over a plate of selenite, and examined by polarised light, the quarters or spaces between the arms of the cross are coloured: those next to each other show complementary tints,—the alternate ones, the same tints. Thus, if the first quarter be green, the third will be green also; but the second and fourth will be red.

FIG. 109.



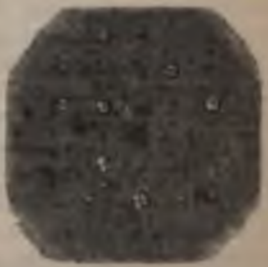
Microscopic Appearance of Light Carbonate of Magnesia.

FIG. 110.



Microscopic Appearance of Heavy Carbonate of Magnesia.

FIG. 111.



Microscopic Appearance of Heavy Carbonate of Magnesia when viewed by Polarised Light.

[Mr. Henry Deane[3] has endeavoured to illustrate the mechanical structure, and causes of the differences in structure, pointed out by Dr. Pereira. To accomplish this object, Mr. Deane dissolved 124 grains of sulphate of magnesia, and 95 grains of bicarbonate of soda, each in four fluidounces of water, mixed the solutions in a flat-bottomed glass vessel, and applied a gentle heat with a gas lamp. In a few minutes effervescence commenced, which rapidly increased with the temperature. At the same time carbonate of magnesia began to separate, partly as a heavy powder free to move in the fluid, partly as an incrustation on the bottom and sides of the vessel, and partly as a pellicle on the surface of the fluid. Before the whole of the carbonic acid was given off, the lamp was removed, and the vessel with its contents set aside for ten hours. On a microscopical examination, the precipitate presented four or five distinct structures or arrangements of crystals.

---

[1] Dr. G. Bird, *Urinary Deposits*, p. 211, 1844.
[2] Dr. A. S. Taylor, *Lond. Med. Gaz.* Sept. 15th, 1848.
[3] *Pharm. Journ.* 1848, p. 266.

On attempting
obtained two or
into the structure
mation, was led to
crystalline form, tl
in arrangement s
temperature emplo
precipitated,—for
where the tempera
Immediately under
small tufts of disti
bodies form, these
to the glass, form
glass giving the cr
any other. Then
accident may dete
decomposing solut
The concentric cha
measure, to the pa
the fluid possessing
the highest temper
nuclei of the two p
light, show the cr
heavy magnesia.

From the experi
and light magnesia
clear that, without
that with it, so far
of water employed
the other kind cann
method must be ad
Mr. Deane obser
Technology,[1] alth
over, Mr. Deane st
crystals were readil
to advance in paral
that pestle-shaped
magnesia are consp

Dr. Gladstone[2] fi
defined varieties of
Deane, that they ha
otherwise expressed
Kobell in the min
resulting from the c
prisms are expressed

Characteristics.
the effervescence wh

Its other characteristics are the same as for the latter substance (see *ante*, p. 644).

COMPOSITION.—The following is the composition of carbonate of magnesia of the shops:—

	At.	*Eq. Wt.*	*Per Cent.*	*Phillips.*	*Fownes.*				*Berzelius.*
					Light of commerce.	Heavy of commerce.	Heavy.	Pattinson's.	
Magnesia	5	100	41·3	40·8	42·8	41·2	41·2	41·6	44·75
Carbonic acid	4	88	36·3	36·0	36·0	36·4	35·6	36·0	35·77
Water	6	54	22·4	23·2	21·2	22·4	23·2	22·4	19·48
Magn. alba, or Magn. Carbonas, *Ph. L.*	1	242	100·0	100·0	100·0	100·0	100·0	100·0	100·00

Several reasons have led chemists to reject the idea of this compound being an ordinary subsalt.[1]

Mr. Phillips[2] (with whom Mr. Fownes concurs) considers it to be probably a compound of

	Atoms.	*Eq. Wt.*	*Per Cent.*
Bihydrated magnesia	1	38	17·7
Hydrated carbonate of magnesia	4	204	84·3
Carbonate of Magnesia, *Ph. L.*	1	242	100·0

PURITY.—Carbonate of magnesia should be perfectly white and tasteless. The water in which it has been boiled should have no alkaline reaction on turmeric paper, nor throw down anything on the addition of chloride of barium or nitrate of silver; by which the absence of alkaline carbonates, sulphates, and chlorides, is proved. Dissolved in dilute acetic acid, the soluble oxalates and carbonates should occasion no precipitate, by which the non-existence of any calcareous salt is shown.[3]

It is dissolved by dilute sulphuric acid. When the effervescence has ceased, bicarbonate of potash does not precipitate anything from this solution. The water in which it is boiled does not alter the colour of turmeric; chloride of barium or nitrate of silver, added to the water, does not precipitate anything.—*Ph. Lond.*

"When dissolved in an excess of muriatic acid, an excess of ammonia occasions only a scanty precipitate of alumina; and the filtered fluid is not precipitated by oxalate of ammonia."—*Ph. Ed.*

PHYSIOLOGICAL EFFECTS.—The effects of carbonate of magnesia are nearly the same as those of pure magnesia. Its local operation must be somewhat milder than that of the latter, but the difference is hardly perceptible in practice. As the carbonate effervesces with acids, it is more apt to create flatulence when swallowed.

USES.—The uses of the carbonate are the same as those of calcined magnesia; except where the object is to neutralise acid in the alimentary canal (as in cardialgia, and in poisoning by the mineral acids), when the latter preparation is to be preferred on account of its not effervescing with acids, and thereby not causing flatulency. It is employed in the preparation of medicated waters.

---

[1] Vide Berzelius, *Traité de Chimie*, vi. 101.

[2] *Translation of the Pharmacopœia.*

[3] A white light siliceous powder, containing animalcules, was imported a few years ago from New Zealand under the name of magnesia. It contained several species of *gallionella* and *navicula* (*Pharmaceutical Journal*, vol. v. p. 72, 1846).

Administration.—The dose of carbonate of magnesia as a purgative is from ten grains to a drachm; as an antacid, from five grains to a scruple.

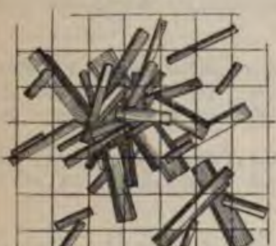
TROCHISCI MAGNESIÆ, E.; *Magnesia Lozenges*. (Carbonate of Magnesia, ℥vj.; Pure Sugar, ℥iij.; Nutmeg, ℈j. Pulverise them, and, with Mucilage of Tragacanth, beat them into a proper mass for making lozenges.) —Employed to counteract acidity of stomach.

2. Magnesiæ Bicarbonas.—Bicarbonate of Magnesia.

Formula $MgO,2CO^2$. *Equivalent Weight* 64.

This salt has hitherto been obtained in solution only. It is procured by dissolving the carbonate of magnesia (*magnesia alba*) in water by the aid of carbonic acid. The solution thus obtained is known by various names: such as *aqua magnesiæ bicarbonatis*, *carbonated magnesia water*, *aërated magnesia water*, *solution of magnesia*, *condensed solution of magnesia*, and *fluid magnesia*. It has a bitterish taste and an alkaline reaction. The late Mr. Dinneford informed me that he prepared his *fluid magnesia* as follows:—Howard's heavy carbonate of magnesia and distilled water, in the proportion of 17½ grs. of the former to f℥j. of the latter, are introduced into a cylindrical tinned copper vessel, and carbonic acid (generated by the action of sulphuric acid on whiting) is forced into it, by means of steam power, for five hours and a half, during the whole of which time the cylinder is kept revolving. The liquid, which is then perfectly clear and transparent, is drawn off, and preserved in cylindrical zinc canisters, each closed by a cork covered by a lid. Dry heavy carbonate of magnesia is less readily dissolved than the moist and recently precipitated carbonate.

Fig. 112.



Crystals of the Hydrated Neutral Carbonate of Magnesia deposited from Dinneford's Solution.

When the solution of bicarbonate of magnesia is exposed for some time to the air, half the carbonic acid escapes, and prismatic crystals of the hydrated neutral carbonate of magnesia are deposited (fig. 112). Their formula, according to Berzelius, is $MgO,CO^2,3HO$; but according to Dr. Davy,[1] $1\frac{1}{2}(MgO,CO^2),4HO$. Fritsche (*Poggend. Ann.* xxxvii. p. 304, 1836) says that two classes of crystals are deposited: one small and acicular, in tufts, and composed of $MgO,CO^2,3HO$; another in tables, and composed of $MgO,CO^2,5HO$.

Sir James Murray's solution is said to contain thirteen grains of carbonate of magnesia to the fluid ounce.[2]

An extemporaneous solution of bicarbonate of magnesia may be obtained by pouring the ordinary bottle soda-water (carbonic acid water) over some common light carbonate of magnesia contained in a tumbler. Another mode of preparing it is by dissolving sulphate of magnesia and bicarbonate of soda, or bicarbonate of potash, in water. The relative proportions to be used are one equivalent or 123 parts of crystallised sulphate of magnesia, and one equivalent or 100 parts of bicarbonate of potash, or one equivalent or 84 parts of bicarbonate of soda. The solution contains, besides bicarbonate of magnesia, sulphate of either potash or soda. Some of the commercial solution of magnesia is prepared in this way. In one case, Mr. Redwood found that there were only 4 grs. of the hydrated carbonate of magnesia of commerce in f℥j. of the solution, which contained at the same time sulphate of soda and a small quantity of sulphate of potash. By dissolving 14 grs. of crystallised sulphate of magnesia, 7 grs. of bicarbonate of soda, and 2½ grs. of crystallised bicarbonate of potash, in an ounce of distilled water, a similar solution might be formed. The presence of sulphuric acid in solution may be readily detected by the chloride of barium. If the solution be evaporated to dryness, and calcined for about ten minutes, the residue ought to be pure magnesia, every five grains of which are equal to twelve grains of the hydrated carbonate (*magnesia alba*) of commerce: if it be treated with distilled water any soluble salts present will be dissolved.

---

[1] *Lond. and Edinb. Phil. Mag.* vol. xvii. p. 346, 1840.
[2] *Pharmaceutical Journal*, vol. v. p. 507, 1846.

Solution of bicarbonate of magnesia is a very agreeable and effective method of administering carbonate of magnesia. It is antacid and mildly laxative. It is employed in dyspepsia, acidity of stomach, and in the uric acid diathesis. Dose f℥ss. to f℥iss. thrice or more daily. It may be used in the preparation of effervescing citrate of magnesia.

88. MAGNESIÆ SULPHAS.–SULPHATE OF MAGNESIA.

Formula MgO,SO^3. *Equivalent Weight* 60.

HISTORY.—This salt was originally procured from the Epsom waters by Dr. Grew.[1] It has had a variety of names; such as *Epsom* or the *bitter purging salt*, *sal anglicum*, *sal seidlitzense*, *sal catharticum*, and *vitriolated magnesia*. At the Lymington salt works it is called *physical salt*, to distinguish it from common salt.

NATURAL HISTORY.—It is a constituent of sea and many mineral waters (see *Sea Water*, p. 301; and *Bitter Purging Waters*, p. 311): it occurs as an efflorescence on other minerals, forming the *hair salt* of mineralogists; and, with sulphate of soda and a little chloride of magnesium, constitutes *reussite*.

PREPARATION.—The two great sources of the sulphate of magnesia of English commerce are *dolomite* and *bittern*.

α. **From Dolomite.**—Dolomite, or magnesian limestone, is a mixture or combination of the carbonates of magnesia and lime. It crystallises in rhombohedrons. It occurs in enormous quantities in various counties of England (as those of Somerset, York, and Nottingham), and is largely employed for building: York Minster and Westminster Hall are built of it.

Various methods of manufacturing sulphate of magnesia from dolomite have been proposed and practised. One method is to heat this mineral with dilute sulphuric acid: carbonic acid escapes, and a residue, composed of sulphate of magnesia and sulphate of lime, is obtained. These two salts are separated from each other by crystallisation. In 1816, Dr. William Henry, of Manchester,[2] took out a patent for the following process:—Calcine magnesian limestone so as to expel the carbonic acid; then convert the caustic lime and magnesia into hydrates by moistening them with water. Afterwards add a sufficient quantity of hydrochloric (or nitric, or acetic) acid (or chlorine) to dissolve the lime, but not the magnesia, which, after being washed, is converted into sulphate by sulphuric acid (or, where the cost of this is objectionable, by sulphate of iron, which is easily decomposed by magnesia). Or the mixed hydrates of lime and magnesia are to be added to bittern: chloride of calcium is formed in solution, while two portions of magnesia (one from the bittern, the other from the magnesian lime) are left unacted on. Or hydrochlorate of ammonia may be used instead of bittern: by the reaction of this on the hydrated

---

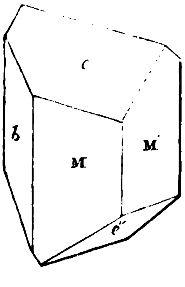
[1] *A Treatise of the Nature and Use of the Bitter Purging Salt*, Lond. 1697.
[2] *Repert. of Arts*, vol. xxx. p. 142, 2d ser.

magnesian lime, ch
while magnesia is le
liquor by distillatio
lime from magnesia
in solution, from w

β. **From Bittern**
sea water, from whi
Chloride of Sodi
(or, as it is there cal
winter season. Th
the summer for the
common salt is dep
and the concentrate
one-eighth part of
singles, are deposit
are then denominat
tons of sulphate are
salt and 1 ton of c
at Lymington; but
quantity of sulphat
magnesium.

At Monte della G
schistose minerals, co
and moistened to con
deprived, first, of cop
sulphate of magnesia is
Hermann[4] extracts it f
of soda. At Baltimor
magnesia or *marmolite*,
and calcining the dried
which solution the rem
By a second crystallisa

Fig. 113.



Common Crystal.

---

[1] *Jou*
[2] Hei
[3] Dr.
[4] Pog
[5] D. I

lisation, become anhydrous, and at a high temperature undergo the igneous fusion, and run into a white enamel, but without suffering decomposition. Exposed to the air, they very slowly and slightly effloresce. They dissolve in their own weight of water at 60°, and in three-fourths of their weight of boiling water. They are insoluble in alcohol; and alcohol precipitates this salt from a strong aqueous solution.

Characteristics.—Sulphate of magnesia is known to contain sulphuric acid by the tests for the sulphates already mentioned. The nature of its base is shown by the tests for magnesia before described (see *ante*, p. 644).

COMPOSITION.—The following is the composition of ordinary crystallised sulphate of magnesia of the shops:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Gay-Lussac.*	*Wenzel.*
Magnesia	1	20	16·26	16·04	16·86
Sulphuric acid	1	40	32·42	32·53	30·64
Water	7	63	51·22	51·43	52·50
Crystallised Sulphate of Magnesia	1	123	100·00	100·00	100·00

PURITY.—The sulphate of magnesia met with in the shops is usually sufficiently pure for all medicinal and pharmaceutical purposes. It should be colourless, and its dilute solution should undergo no change when mixed with ferrocyanides or hydrosulphurets. When obtained from bittern, it is sometimes contaminated with chloride of magnesium, which, by its affinity for water, keeps the sulphate in a damp state. By digestion in alcohol, the chloride is dissolved; and, by evaporation, the spirituous solution may be obtained in the solid state. [In order to separate any chloride of magnesium, and obtain the sulphate pure, M. Weber[1] proposes to heat the commercial sulphate with sulphuric acid, and separate the hydrochloric acid by distillation. When the whole of this has been expelled, the acid liquid may be neutralised by the addition of a little carbonate of magnesia, a slight excess of which is not objectionable, but, on the contrary, precipitates the iron so frequently present in sulphate of magnesia. For the perfect separation of the iron it is necessary to allow the solution to digest for some time with the carbonate of magnesia.—ED.]

It is said that the sulphate of magnesia of the shops is generally adulterated with sulphate of soda.[2] There are several methods of detecting the fraud: the sophisticated salt would effloresce more rapidly than the pure salt, and would communicate a yellow tinge to the flame of alcohol. Boiled with caustic lime and water, all the magnesian sulphate would be decomposed, and the liquor being filtered (to separate the precipitated magnesia and sulphate of lime), would yield, on evaporation, sulphate of soda. If shaken in the cold with carbonate of baryta, a solution of carbonate of soda would be obtained, easily recognised by its alkaline properties. One hundred grains of pure crystallised sulphate of magnesia should yield 16¼ grains of calcined magnesia.

It does not deliquesce when exposed to air. It is readily dissolved by water. Sulphuric acid dropped into the solution does not expel any hydrochloric acid.—*Ph. Lond.*

The evolution of hydrochloric acid gas would be a proof of the presence of

---

[1] *Pharmaceutical Journal*, June 1853, p. 596; and *Allgemeine Pharmaceutische Zeitschrift.*

[2] *Pharmaceutical Journal*, vol. iii. p. 491, 1844.

a chloride. If le
dried precipitate o
100 grains of sulp
of soda may be su

"Ten grains dissol
of ammonia, are not
—*Ph. Ed.*

PHYSIOLOGICAL
mild and perfectly
as well as the peri
its operation to su
otherwise disorde
speedily on the bo
of the vegetable p
or inflammatory sy
hence it is commo
with aqueous flui
of other emuncto
be conjoined, it
supposed poisonin
The symptoms w
breathing, extrem
More recently, an
several pints of be
violent purging, a
not ascertained, b

USES.—On acc
solubility, and its
employed purgativ
tion to its use is it
which it is admini
of known diseases
excellently well ad
obstinate constipa
poisoning, &c. I
lead and baryta.

ADMINISTRATIO
from half an ounc
ing, a smaller dose
will usually produ
peppermint water
flatulency. In fe
lated with dilute s

---

[1] *Treatise on Poison*
[2] Dr. A. S. Taylor,
[3] Sulphate of magne
from the late Mr. Youa
use the sulphate of mag
I purge the larger elep
pound and a half of Ep

dissolved in the compound infusion of roses. It is frequently used as an adjunct to the compound infusion of senna, whose purgative effect it promotes, but whose griping tendency it is said to check. In dyspeptic cases, accompanied with constipation, it is conjoined with bitter infusions (as of quassia, gentian, and calumba). As a purgative enema, an ounce or more of it may be added to the ordinary clyster.

The *bitter purging saline* waters owe their activity chiefly to sulphate of magnesia.

PULVIS SALINUS COMPOSITUS, E.; *Compound Saline Powder*. (Take of Pure Muriate of Soda and Sulphate of Magnesia [of each], ℥iv.; Sulphate of Potash, ℥iij. Dry the salts separately with a gentle heat, and pulverise each, then triturate them well together, and preserve the mixture in well-closed vessels.)—A mild, cooling, saline aperient. May be employed in habitual constipation. Dose, ʒij. or ʒiij. It may be taken dissolved in half a pint of plain water, or in bottled soda water (carbonic acid water).

89. Magnesiæ Citras.—Citrate of Magnesia.

Formula $3MgO,C^{12}H^{5}O^{11},HO$; or $3MgO,\overline{Ci},HO$. *Equivalent Weight* 234.

Citrate of magnesia may be prepared by saturating a solution of citric acid with either magnesia or its carbonate. Provided the ingredients be pure, 1 equivalent or 201 grs. of crystallised citric acid should saturate 3 equivalents or 60 grains of calcined magnesia, or 145·2 grs. of the carbonate of magnesia of the shops. I find that ℈j. of the crystallised acid of commerce saturates about 14 grs. of either light or heavy carbonate of magnesia. If a somewhat concentrated solution of the acid be saturated with magnesia, the liquor becomes a hard solid, owing to the union of the salt with the water. Another mode of preparing citrate of magnesia is by double decomposition from sulphate of magnesia and citrate of soda.

PROPERTIES.—Neutral citrate of magnesia is a white, pulverulent, insipid salt, soft to the touch, heavier than magnesia, and, when aided by the addition of a slight excess of the acid, soluble in water. This solution has an acid taste, and is devoid of that unpleasant bitter flavour which usually characterises the magnesian salts. According to Roge Delabarre,[1] the composition of this crystallised salt is as follows:—

	Atoms.	*Eq. Wt.*	*Per Cent.*
Citric acid	1	165	50·926
Magnesia	3	60	18·518
Constitutional water	1	9	2·777
Water of crystallisation	10	90	27·777
Crystallised Citrate of Magnesia	1	324	100·000

Citrate of magnesia is a mild and agreeable aperient. Its superiority over other saline purgatives consists in its being devoid of any unpleasant flavour. Although weight for weight it contains rather more magnesia than the sulphate of magnesia, its operation is milder. The dose of it as a purgative is from ʒviij. to ʒx. for adults.

A solution of this salt in water, acidulated with citric acid and flavoured with syrup of orange peel, forms what has been called *magnesian lemonade*. If taken in the effervescing state it constitutes *effervescing magnesian lemonade*. Four drachms of crystallised citric acid, and three and a half drachms of the common carbonate of magnesia, dissolved in a sufficiency of water, yield rather more than an ounce of solid citrate of magnesia.

1. LIQUOR MAGNESIÆ CITRATIS; *Solution of Citrate of Magnesia; Magnesian Lemonade.*—Take of Citric Acid, ʒss.; Carbonate of Magnesia, ℈j.; Syrup of Orange Peel,

---

[1] *Pharmaceutical Journal*, vol. vii. p. 17, 1847.

ʒij.; Distilled Water
44½ grs. of crystallis
magnesia dissolves sl
2. Liquor Magn
Magnesia; Effervesci
℥j.; Syrup of Orange
bicarbonate of magn
vescing draught.

90. M

Formula

Magnesia Tartaric
or its carbonate, and
of tartrate of magnes
in painful chronic ma
Moxon's Aperien
effervescent form, alo
has enjoyed considera
as a remedy in indi
imitation of it:—Ta
Bicarbonate of Soda,
These ingredients
then reduced to powd
corks adapted to th
the mixture, carbonic
Dose, a tea-spoonful

Order

Aluminum, Alu
the earth alumina.

Oxide of Aluminu
aluminosa or *Aluminor*
and *corundum*. Alun
the hydrated form as
medicinally.
1. Aluminæ Hyd
Add to a solution of a
cipitate repeatedly or
sufficiently pure for n
interfere with its the
solved in diluted hy
ammonia. The precip

1
2

and dried between bibulous paper. If the precipitated hydrate be dried at a temperature of between 70° and 80° it contains about 58 per cent. of water, and is an *octohydrate of alumina*, $Al^2O^3,3HO$: if it be dried at 212° it becomes a *terhydrate*, $Al^2O^3,3HO$. Hydrate of alumina is white and tasteless; it is insoluble in water, but is soluble in most acid liquids.

Hydrate of alumina dissolves in the acid gastric liquor, forming aluminous saline solution, which is astringent, and acts mildly as a chemical agent on the animal tissues like alum. In the intestinal canal, the aluminous salts, meeting with alkaline juices, suffer decomposition, and are converted into insoluble subsalts; which, according to Mialhe,[1] act chemico-mechanically, and close the excreting pores. Gradually, however, these subsalts are deprived of their acid constituent, and the alumina dissolves in the alkaline liquid. The alkaline aluminate thus formed is perhaps in part rejected from the bowels, and in part absorbed into the blood. Hydrate of alumina has been employed, as an antacid and astringent, in acidity of stomach, in diarrhœa, dysentery, and cholera. Ficinus[2] considered it superior to other absorbents (as the alkalies, chalk, and magnesia), because the salts which it forms, by union with the acids of the gastric and intestinal juices, are astringent; whereas the others are mostly laxative. It seems well adapted for the vomiting and diarrhœa of infancy, as these maladies are frequently or usually accompanied by preternatural acidity. Seiler,[3] Weese,[4] Neumann,[5] and Durr,[6] have spoken in high terms of its efficacy in those cases. It has also been employed as a topical remedy in catarrhal affections of the conjunctiva.[7] The dose of it for children is from 3 to 10 grs. A young child should take from ℈ss. to ℈j. in 24 hours; older children from ℈j. to ℈ij. It should be administered suspended in water, or in an emulsion, by sugar or gum.

2. TERRÆ ALUMINOSÆ.—From the most ancient times various aluminous earths have been employed in medicine. They consist chiefly of silica and alumina, usually more or less coloured by iron; their medicinal properties being for the most part due to alumina. They were employed principally as astringents in alvine fluxes. Dale[8] has given a very complete notice of them. He arranges them under two heads, *boles* (*boli*) and *clays* (*argillæ*). The *marls* (*margæ* vel *lutræ*) are intermediate between clay and chalk.

The only substances of this kind now professed to be kept in the shops is *red Armenian bole* (*bolus armena rubra*) or, as it is commonly called, *bole armeniack*. It is found in Armenia (whence its name), as well as in various parts of Europe. According to Bergmann, it consists of *silica* 47, *alumina* 19, *magnesia* 6·2, *lime* 5·4, *iron* 5·4, and *water* 7·5. But the substance usually sold as red Armenian bole is an artificial mixture prepared by grinding together, in a mill, *pipe clay* and *Venetian red* (red oxide of iron), and afterwards levigating the mixture. Its principal use is as a tooth-powder.

Lemnian earth, or the earth of *Lemnos* (*terra Lemnia*) is dug up at Lemnos once a year (on the 15th of August), in the presence of the clergy and magistrates of the island, after the reading of prayers.[9] It is formed into flat cylindrical discs, which are stamped and sold as *sealed earth* or *terra sigillata*. According to Klaproth, it consists of *silica* 66, *alumina* 14·5, *magnesia* 0·25, *lime* 0·25, *natron* 3·5, *oxide of iron* 6, and *water* 8·5. Galen went to Lemnos on purpose to examine this earth.

Fuller's earth (*smectis* vel *terra fullonica*; the *creta cimolia* of Pliny) is dug in Buckinghamshire, Surrey, and Hampshire. According to Klaproth, that obtained at Reigate consists of *silica* 53, *alumina* 10, *magnesia* 1·25, *lime* 0·50, *common salt* 0·10, *potash* a trace, *oxide of iron* 9·75, and *water* 24. It is desiccant and astringent. Nurses sometimes apply it to surfaces irritated by acrid discharges, urine, &c.

---

[1] *Traité de l'Art de Formuler*, 1845.

[2] *Zeitschrift f. Natur u. Heilk. d. Dresdener Professoren*, Bd. i. H. i. S. 82 (quoted by Richter, *Ausf. Arzneimittellehre*, Bd. iii. S. 603).

[3] *Ibid.*

[4] Rust's *Magazin*, Bd. ii. S. 247.

[5] *Bemerkungen über die gebräuchlichsten Arzneimittel.* 1840 (quoted by Dunglison, *New Remedies*, Philadelphia, 1843).

[6] Hufeland's *Journal*, 1835 (quoted by Riecke, *Die neuern Arzneimittel*. 2te Aufl. 1840).

[7] *Die neuern Arzneimittel. und Arzneibereitungsformen*, von Dr. M. Aschenbrenner, 1848.

[8] *Pharmacologia*, 3tia ed. 1737.

[9] Jameson's *Mineralogy*, vol. i. p. 408, 2d edit. 1816.

92. ALUME

Formula

HISTORY.—Alt
of the Greeks) oc
Dioscorides,[4] and
our alum was th
Beckmann[5] has as
of iron, and that
century. But Ge
acquainted with al
I think, improbab
not distinguish it

Common or pot
pharmacy. It is
aluminæ et potas
sulphate of pota

NATURAL HIST
and constitutes th

PREPARATION.—
places. The mi
aluminous slate,
naris). This su
localities, but alw
times a salt of p
alum manufactorie
alum manufactory
aluminous schist
action of the air i
the mine. The su
which combines p
alumina. By lixi
obtained: this is
centrated is run in
sulphate of alumi
sulphate of potas
alum are obtained
quisite potash salt

---

[1] Lib. ii. (*Euterpe*),
[2] *De Fistulis, De Ul*
[3] *Hist. Nat.* xxxv.
[4] Lib. v. cap. 123.
[5] *Hist. of Invent.* i.
[6] *Search of Perfectio*
[7] For further informa
Chemistry, i. 125.
[8] Williams, *Natural*

soap-boilers' liquors. When chloride of potassium is used, it decomposes the sulphate of iron, and yields chloride of iron and sulphate of potash. At Whitby, in Yorkshire, the method of making alum is somewhat different. The schist is piled in heaps, and burnt by means of a slow smothered fire. The calcined ore is lixiviated, and a salt of potash added to the solution after it has deposited sulphates of lime and iron, and earthy matters.[1]

Of late years, sulphate of ammonia, obtained from gas liquor, has been employed as a substitute for the sulphate of potash or chloride of potassium. In general, the alum made at Hurlet contains both potash and ammonia.[2]

[Mr. Spence,[3] of Manchester, has patented some recent improvements in the manufacture of alum. The alum shale, or schist, is roasted in heaps in the open air, in order to render it porous and more absorbent of the sulphuric acid. To the roasted shale, sulphuric acid of sp. gr. 1·75 is added, by which means sulphate of alumina is formed. In order to wash out this sulphate, and supply the equivalent of ammonia necessary to constitute the double salt of alum and ammonia and alumina, the boiling-hot mother-liquor of a previous operation is employed, and as this mother-liquor, when removed from the alum crystallisers, contains free sulphuric acid, the ammonia from a still containing the ammoniacal liquor of the gas-works is distilled into it, and the boiling-hot solution of sulphate of ammonia then formed dissolves out the sulphate of alumina from the shale. The alum liquor thus obtained is of such specific gravity that it crystallises without having recourse to evaporation, and thus a considerable saving in fuel is effected.

The Boghead Cannel coal, which, on account of the large quantity of gas yielded by its distillation, has lately been introduced from Scotland for the purpose of gas-making, contains a large quantity of alumina, and a patent has recently been specified by Messrs. Barlow and Gore for a method of treating the residuum of the distillation of this coal, and manufacturing alum therefrom. This residuary ash, whether resulting from the combustion of the coke, or from its treatment by steam, as adopted by the patentees for obtaining certain gases, is placed in suitable vessels or boilers, and subjected to the action of heated dilute sulphuric acid; the result of which is the solution of the alumina contained in the ash, and the formation of sulphate of alumina. The solution of aluminous sulphate thus obtained may be evaporated so as to yield that salt, or it may be mixed with the proper quantity of either sulphate of potash or sulphate of ammonia in solution, whereby the ordinary commercial alum is obtained by evaporation and crystallisation in the usual way. The residuary silica is applicable to the manufacture of glass, and other useful purposes in the arts.[4]—ED.]

PROPERTIES.—Alum crystallises usually in regular octohedrons, frequently with truncated edges and angles, and sometimes in cubes. The ordinary alum of the shops consists of large crystalline masses, which do not present any regular geometrical form; but, by immersion in water during a few days, octohedral and rectangular forms are developed on its surfaces.[5] Alum has an astringent and sw

---

[1] Winter, in *Nicholson's Journal*, vol. xxv.

[2] Dr. T. Thomson, in *Athenæum* for 1840, p. 771.

[3] *Pharmaceutical Journal*, 1850–51, p. 606.

[4] *Ibid.* 1851–52, p. 231.

[5] Daniell, *Quarterly Journal*, i. 24.

FIG. 115.

Octohedron of Alum.

o
a
d
u
o
d
p
p
a
p
n

charcoal, or some
inflammable subst
potassium, alumin

Alum dissolves
weight of boiling

Under the nam
commerce a factit
larger than almon
obvious imitation
times *alumen ru*
has been denomin

Matthiolus,[2] who
(a town in the Pa
called by the Italian
two kinds; one har
from the white stone
contrary, is reddish,
dyers, as well as by
there are two kinds
name of *alumen rup*
Dale,[4] and some oth
common white alum
English commerce t

The pure crystals
sulphate of alumina
found 56 per cent.,
" Alum-stone appear
volcanic districts, by
volcanic rock, comp

It appears that
states that " it differ
contain more alumin
cold water and slow
heated to 110° or hi
Roman alum has not

Characteristic

---

[1] Valentini, *Hist. S*

[2] *Commentarii in li*

[3] " The most ancien
Mineralogy, vol. i. p.

[4] *Pharmacologia*, 3

soluble sulphates already mentioned. Its solution in water reddens litmus, and forms sulphate of lead when mixed with pure carbonate of lead: in these properties it agrees with the supersulphates. The nature of its basic constituents is shown by the following tests:—The ferrocyanides, the oxalates, and hydrosulphuric acid, occasion no precipitate in a solution of pure alum. Hydrosulphuret of ammonia, the caustic alkalies and their carbonates, and phosphate of soda, throw down white precipitates: that produced by the alkalies is soluble in an excess of alkali, but is insoluble in solutions of the carbonated alkalies: these characters show the presence of alumina. Potash is recognised in it by perchloric acid and bichloride of platinum. When heated with caustic potash or lime, pure potash-alum evolves no ammonia. Lastly, the crystalline form of the salt assists in recognising it.

COMPOSITION.—The composition of alum is as follows:—

	At.	Eq. Wt.	Per Ct.	Berzel.	Thomson.
Alumina	1	52	10·92	10·76	11·00
Potash	1	48	10·08	9·95	9·86
Sulphuric acid	4	160	33·68	33·74	32·85
Water	24	216	45·32	45·55	46·29
Cryst. Potª. Alum	1	476	100·00	100·00	100·00

or

	At.	Eq. Wt.	Per Ct.	Graham.
Sulphate of alumina	1	172	36·13	54·11
Sulphate of potash	1	88	18·48	
Water	24	216	45·39	45·89
Cryst. Potash Alum	1	476	100·00	100·00

PURITY.—Alum should be colourless, completely soluble in water (by which the absence of uncombined earthy matter is shown); with a solution of caustic potash or ammonia, it should form a colourless precipitate of hydrate of alumina, completely soluble in excess of potash, but not in ammonia. It should not suffer any change of colour by the addition of tincture of nutgalls or hydrosulphuric acid. The ferro-sulphate of potash, sometimes mixed with alum, cannot be distinguished from the latter by its form, colour, or taste; but is readily detected by potash, which throws down oxide of iron; and by tincture of nutgalls, which communicates a bluish-black colour to it. [Iron is detected in alum by precipitating the alumina by potash, redissolving the precipitate by an excess of alkali, and allowing the mixture to stand. If iron be present, it is slowly deposited as a flocculent red oxide.—ED.]

PHYSIOLOGICAL EFFECTS. α. *On Vegetables.*—Alum is probably injurious to plants.[1]

β. *On Animals.*—Dogs support large doses of alum with impunity. Orfila[2] gave seven drachms of *crystallised* alum in powder to dogs: the animals retained it for from ten to thirty minutes, then vomited, and in an hour or two were apparently well. Two ounces of *burnt* alum in four ounces of cold water occasioned vomiting only. When the œsophagus was tied to prevent vomiting, death took place in five hours, with symptoms of great exhaustion and diminished sensibility. On a post-mortem examination, the mucous membrane of the stomach was found inflamed in the whole of its extent. One ounce of finely-powdered burnt alum applied to the subcutaneous cellular tissue of the thigh, caused excessive suppuration, and death in fifteen hours. Devergie[3] found burnt alum somewhat more active: he says 6½ drachms killed a dog when the œsophagus was tied, and 2 ounces when it was not tied. Moreover, he found burnt alum suspended in cold water more active than when dissolved in warm water. Veterinarians employ it in doses of from one

---

[1] De Candolle, *Physiol. Végét.* p. 1341.
[2] *Ann. d'Hyg. Publique et de Méd. Lég.* i. 235.
[3] *Méd. Légale*, ii. 653.

to six drachms for
induced in horses

γ. On Man.—
a solution of it in
a white precipitate.
gelatine. These
albuminous, and g
pound which alum
acids, and the alum
nor by potash.[2]
accounts for the a
by the alkali of the
is used this sub-s
saturation of all t
appears to be unte

The immediate
—namely, corruga
which it checks or
paleness of parts b
is by these local e
the mouth and thr
alimentary canal,
sistency of the sto
himself with alum
and taken several
in larger quantities
irritation, and the
nally in large dose
an inflammatory c
induced by small
sibility of the stom
ous gastro-enteriti
taining between te
tolerably large do
Thus Professor D
diarrhœas within t
hemorrhages withi
have administered

Alum becomes
urine of animals t
alum appears to
generally, and to
fibres, and a dimin
some passive hem

---

[1]
[2]
[3]
[4]
[5]
[6]
[7]

tates the lungs, and often produces cough," but I am not aware of any other practitioner having confirmed this statement. Kraus[1] observes, that the urine becomes remarkably acid from the use of alum.

USES.—Alum is employed both as an external or topical, and as an internal remedy.

a. As a topical remedy.—Solutions of alum are sometimes employed *to produce contraction or corrugation of the tissues*, and thereby to prevent displacement of parts, especially when accompanied with excessive secretion. Thus it is used as a gargle in relaxation of the uvula with evident advantage. In the early stage of prolapsus of the rectum, a solution of alum, applied as a wash, is sometimes of service, especially when the disease occurs in infants. Washes or injections containing alum are of occasional benefit in prolapsus of the uterus. In hemorrhages, whether proceeding from an exhalation or exudation from the extremities or pores of the minute vessels, or from the rupture of a blood-vessel, a solution, or in some cases the powder, of alum, may be used with advantage as a *styptic*, to constringe the capillary vessels, and close their bleeding orifices. Thus in epistaxis, when it is considered advisable to arrest the hemorrhage, assistance may be gained by the injection of alum into the nostrils, or by the introduction of lint moistened with the solution. Where this fails to give relief, finely-powdered alum may be employed in the manner of snuff. In hemorrhage from the mouth or throat, gargles containing alum are useful. In hæmatemesis, as well as in intestinal hemorrhage, alum whey may be administered; though, of course, no reliance can be placed on it, as the hemorrhage usually depends on circumstances which astringents merely cannot be expected to obviate. In uterine hemorrhage, a sponge soaked in a solution of alum may be introduced into the vagina with good effect. To check the hemorrhoidal flux when immoderate, washes or enemata containing alum may be employed. To stop the bleeding after leech-bites in children, a saturated solution, or the powder of alum, may be applied to the punctures.

In certain inflammations, alum has been used as a *repellent;* that is, it has been applied to the inflamed part in order to produce contraction of the distended vessels, and thereby to diminish the quantity of blood in the seat of the disease in a manner almost mechanical. Thus, in the first stage of ophthalmia it is sometimes considered expedient to cut short the disease by the application of a strong astringent solution (as a saturated solution of alum or of acetate of lead). "It is not to be denied," observes Dr. Jacob,[2] "that such applications may have the effect of arresting the progress of the disease at once; but if they have not that effect, they are liable to produce an increase of irritation." But, as the details necessary for making the student acquainted with all the circumstances respecting the use of stimulating or astringent applications in the first stage of ophthalmia are too lengthened and numerous to admit of their proper discussion in this work, I must refer for further particulars to the essay of Dr. Jacob before quoted, as well as to the treatises of writers on ophthalmic surgery. I may, however, add, that whatever difference of opinion exists as to the propriety of these applications in the first stage of ophthalmia, all are agreed as to their value after the violence of vascular action has been subdued. In the treatment of the purulent ophthalmia of infants, no remedy is perhaps equal to an alum wash.

---

[1] *Heilmittellehre*, 255.

[2] *Cyclopædia of Practical Medicine*, art. *Ophthalmia.*

In angina membranacea, called by Bretonneau[1] diphtheritis, great importance has been attached to the employment of local applications. Of these, hydrochloric acid, calomel, and alum, have, in succession, been highly praised by this writer. In order to promote the expulsion of the false membrane, he recommends the insufflation of finely-powdered alum. This is effected by placing a drachm of it in a tube, and blowing it into the throat.[2] Velpeau has subsequently confirmed the statements of Bretonneau, and extended the use of alum to other inflammatory affections of the throat, as those arising in scarlatina, and small-pox. In these cases, powdered alum may be applied to the affected part by means of the index finger. Gargles containing this salt will be found useful in most kinds of sore-throat, ulcerations of the mouth and gums, aphthæ, &c. In inflammation of the uvula, accompanied with membraniform exudation, alum washes are serviceable both in children and adults.[3] Alum has been employed as an *astringent*, to diminish or stop excessive secretion from the mucous surfaces. Thus a weak solution of this salt is used to repress the discharge in the latter stages of conjunctival inflammation;[4] to check profuse ptyalism, whether from the use of mercury or other causes; and to remove gleet or leucorrhœa. In old-standing diarrhœas, it has been administered, in combination with the vegetable astringents (kino, for example), with occasional advantage. It is also applied to check profuse secretion from ulcers.

β. As an internal remedy.—Alum has been employed, in conjunction with nutmeg, as a remedy for intermittents. Given just before the expected paroxysm, it has, in some cases, prevented it.[5]

In the treatment of *lead colic*, alum has been found more successful than any other agent or class of remedies. It was first used in this disease by a Dutch physician, named Grashuis,[6] and was afterwards administered in fifteen cases by Dr. Percival[7] with great success. Its efficacy has been fully established by Kapeler (physician to the Hôpital St-Antoine, in Paris) and Gendrin,[8] and by Dr. Copland,[9] as well as by several other distinguished authorities. It allays vomiting, abates flatulence, mitigates pain, and opens the bowels more certainly than any other medicine, and frequently when other powerful remedies have failed. It should be given in full doses (as from a scruple to two drachms), dissolved in some demulcent liquid (as gum-water), every three or four hours. Opium and (according to Dr. Copland) camphor may be advantageously conjoined. Kapeler also employs oleaginous enemata. The modus operandi of alum in lead colic is not very clear. The benefit has been ascribed by some to the chemical action of the sulphuric acid on the lead contained in the intestines; and in support of this view must be mentioned the fact, that other sulphates (as those of magnesia, soda, zinc, and copper), as well as free sulphuric acid, have been successfully employed in lead colic. But, on the other hand, the presence of lead in the primæ viæ or evacuations, and, subsequently, the formation of sulphate of lead in saturnine colic, have not been demonstrated; though the experiments of Dr. C. G. Mitscherlich[1] have shown that, when the acetate of lead is swallowed, the greater part of it forms an insoluble combination with the gastro-intestinal mucus, and in this state may remain some time in the alimentary canal. Moreover, alum has been found successful by Kopp[2] in other varieties of colic not caused by lead, and unaccompanied by constipation. Dr. Copland is disposed to ascribe the benefit of alum and other sulphates in lead colic to their "exciting the action of the partially-paralysed muscular coat of the bowels, and thereby enabling them to expel retained matters of a morbid or noxious description,"—an explanation which is inconsistent with the observation of Kopp just quoted. [Alum appears to exert a special local influence upon the intestinal tube. It has been found by M. Phillipeau,[3] of Lyons, to be efficacious in the treatment of nervous colic, as, according to Broches, it is in lead colic.—ED.]

---

[1] *Rech. sur l'Inflam. spéc. du Tissu Muqueux*, 1826.

[2] See also Trousseau and Pidoux, *Traité de Thérap.* ii. 291.

[3] Trousseau and Pidoux, *op. cit.*

[4] [*Natural Aluminous Water.*—Mr. Thomas Beesley, in the analysis of a mineral water near Banbury, has found tersulphate of alumina to be the most abundant of its saline matters. By the action of salts of lime the tersulphate is decomposed and reduced to the basic sulphate. The water is distinctly acid to the taste as it issues from the ground. The salt is probably due to the oxidation of iron pyrites, and the action of the consequent sulphuric acid upon the alumina of the clay. This water is used by the country people as eye-lotion. (*Pharm. Journal*, 1849–50, p. 452.)—Ed.]

[5] Cullen, *Materia Medica.*

[6] *De Colica Pictonum*, Amst. 1752, et *Append.* 1755.

[7] *Essays, Med. and Exper.* ii. 194.

[8] Quoted by Trousseau and Pidoux, *op. cit.*

[9] *Dict. of Med.* i. 374.

Alum is administered *internally* in several other diseases, of which a brief notice only can be given. In passive or asthenic hemorrhages from distant organs; as hæmoptysis, menorrhagia and other uterine hemorrhages, and hæmaturia. In colliquative sweating, pertussis in the chronic form, diabetes, gleet, gonorrhœa, and leucorrhœa. In the three latter diseases it may be combined with cubebs. Kreysig[4] has advised its use in dilatation of the heart and aortic aneurism. More recently, Dzondi[5] has also recommended it in these diseases; and Sundelin[6] has mentioned a case of supposed dilatation of the heart in which relief was gained by the use of alum. In chronic diarrhœa, alum is occasionally serviceable. [Dr. Meigs,[7] of Philadelphia, has given a teaspoonful of powdered alum as an emetic in cases of croup, and prefers it to any other emetic in this disease.—ED.]

ADMINISTRATION.—The dose of alum is from ten grains to one or two scruples. It may be taken in the form of powder, or made into pills with some tonic extract, or in solution. To prevent nausea, an aromatic (as nutmeg) should be conjoined. A pleasant mode of exhibition is in the form of *alum whey* (*serum aluminosum*, seu *serum lactis aluminatum*), prepared by boiling two drachms of powdered alum with a pint of milk, then straining: the dose is a wine-glassful. The *saccharum aluminatum* of the Prussian Pharmacopœia is composed of equal parts of white sugar and alum: it may be given to children as well as adults. In prescribing alum, it is to be remembered that the vegetable astringents decompose it; by which the astringent property of the mixture is probably diminished. For topical uses

---

[1] Müller's *Archiv*, No. v. 353, 1836, quoted in *Brit. Ann. of Med.* vol. i. 204, 1837.

[2] *Denkwurdigkeit*, i. 342, quoted by Richter, *Ausführl. Arzneim.* Suppl. Bd. 515.

[3] *Bulletin Thérapeutique Médicale*, t. xxxix. p. 485.

[4] *Die Krankh. d. Herzens*, Bd. ii. Abt. 2, S. 714, in Richter, *op. cit.*

[5] *Aeskulap.* Bd. i. St. 1, 1821, in Richter.

[6] *Heilmittellehre*, ii. 278.

[7] *Bulletin Thérapeutique Médicale*, t. xxxv. p. 430.

alum is employed in
crystallised alum is
Solutions of alum ar
ing to the object in

ANTIDOTE.—In a
be immediately eva
The inflammatory s
means. Magnesia
useless. [Small do
in neutralising the

1. ALUMEN EXSI
Alumen ustum ; B
the heat until ebulli
Dublin Colleges s
alum to be afterward
care must be taken
driven off as well as
preferable to a cruci
dissolve so readily i
escharotic to destr
known under the na
of crystallisation wi

2. LIQUOR ALUM
Aqua Aluminosa
Zinc, each ℥j.; Bo
zinc together in th
detergent and astri
mild conjunctival i
as an application to

3. PULVIS ALUM
(Alum, ℥iv.; Kin
Astringent. Empl
in old diarrhœas ;

[9

[This salt was first
some ferruginous com
Smith, who reports it
to produce the stimul
of iron takes the place
24Aq. It is prepared
or by peroxidising prot
of potash. Ammonia
alkalies for that of po
It is distinguished fro
formed on the additio
while with the other i

Mr. Davenport proposes in lieu of the rather indefinite name "iron alum" to designate this salt as the *ammonio-sulphate of peroxide of iron*, or *potassio-sulphate of peroxide of iron*, according to the salt employed in its formation.—ED.]

94. Aluminæ Acetas.—Acetate of Alumina.

Formula $Al^2O^3,3C^4H^3O^3$; or $Al^2O^3,3\bar{A}$. *Equivalent Weight* 205.

Argilla Acetica.—Obtained by digesting hydrate of alumina in strong acetic acid until the acid is saturated. If heat be applied it occasions the precipitation of a subsalt of alumina. For pharmaceutical purposes, the solution is sometimes directed to be evaporated by a gentle heat to a gelatinous consistence.[1] The solution of acetate of alumina has a styptic, somewhat sweetish taste; and, by spontaneous evaporation, yields long, transparent crystals. By exposure to a very gentle heat, these become pulverulent, and in this state consist[2] of $Al^2O^3,3\bar{A},3HO$.—An impure solution of acetate of alumina may be obtained by mixing a solution of alum with one of sugar of lead: sulphate of lead is precipitated, and the acetate of alumina remains in solution mixed with either sulphate or acetate of potash. If 476 grs. of alum be decomposed by 760 grs. of crystallised acetate of lead, the acetates of alumina and potash are left in solution; but if 476 grains of alum be decomposed by only 570 grs. of crystallised acetate of lead, the acetate of alumina and sulphate of potash are left in solution.—Acetate of alumina possesses astringent and antiseptic properties. It has been used in hæmoptysis, diarrhœa, and gonorrhœa: in the latter complaint it has been both administered internally and applied as an injection. Gannal[3] has employed it as a preservative of dead animal matter. To preserve bodies, he injects five or six pints of a solution of acetate of alumina by the carotid artery. In this way all parts (except the brain) may be preserved for years. The parts thus prepared evolve the odour of acetic acid,[4] and corrode the scalpels.—Dose from ʒss. to ʒj. daily in a mucilaginous decoction; for injections, from gr. x. to gr. xv. in three fluidounces of distilled water.

ORDER XVIII. COMPOUNDS OF CHROMIUM.

Some few of the compounds of the metal *Chromium* (Cr=28) have been employed in medicine; and on this account, as well as from the circumstance that occasionally they have been taken as poisons, a short notice of some of them appears desirable.

95. Acidum Chromicum.—Chromic Acid.

Formula CrO^3. *Equivalent Weight* 52.

Peroxide of Chromium.—The readiest mode of obtaining it is as follows:—Add 1½ measures of concentrated oil of vitriol (free from lead) to 1 measure of a cold saturated solution of bichromate of potash. Dark crimson needles of chromic acid are deposited: decant the liquid, and place the crystals on a thick, flat tile of biscuit porcelain; compress for a considerable time the crystals by another tile placed over them. On removing the chromic acid, it will be found dry.[5] According to Schröffer,[6] acid thus obtained contains 6 or 7 per cent. of potash, and 0·7 of sulphuric acid. For medicinal purposes, however, this impurity is unimportant.—Chromic acid occurs in ruby red, prismatic, deliquescent crystals, whose taste is sour, acrid, and metallic. It is soluble in water, but the solution

---

[1] Geiger, *Pharmacopœia Universalis.*

[2] Thomson, *An Attempt to establish the First Principles of Chemistry*, vol. ii. p. 315, 1825.

[3] *Histoire des Embaumements*, Paris, 1838.

[4] Mérat, *Supplément au Dict. Univ. de Mat. Méd.* p. 31, 1846.

[5] Warington, *Proceedings of the Chemical Society*, Dec. 7, 1841.

[6] *Chemical Gazette*, Oct. 1843.

is decomposed by solar
alcohol, and from this
oxidising and bleaching
and passing to the sta
skin yellow, and the s
surface is that of a c
painful wounds. The
use the bichromate of
acid. If swallowed, t
mineral acids. Mr. U
for application, inasmu
managed, does not spr
tion is finished, passes
with success as an app
burning pain and the
withered and shrunk,
ployed as a bleaching
best antidotes would b
water (see *Potassæ Bi*

96. Pot

Two compounds of
bichromate.

1. Potassæ Chrom
flavum, KO,CrO^3; Eq
native chromite of iro
of potash by water, an
stituted for nitrate of p
Chromate of potash f
prismatic rhombic syst
states that chromate o
for chromate of potash
whereas those of chro
potash is irritant and
poison. In smaller d
tartarised antimony, t
specifically on the muc
mucous membranes, w
and also on the nervou
that a drachm of it i
neck, caused on the
vomiting of a frothy m
on the third day vomit
day difficulty of breath
feet; and on the sixth
membranous, polypous
nose was filled with a
the same kind of secre

---

[1] *Journal of the Phil*
p. 439, 1834.

[2] *London Medical Ga*

[3] Knapp's *Chemical T*

[4] *Pharmaceutishes Ce*

[5] *Versuche über die*
Orfila, and several other
only chromate whose ef
chromsaures kali).

[6] *British and Foreign*

its effects similar to, but somewhat milder than, those of the bichromate. Chromate of potash has been employed medicinally by Jacobson, Jenson, Radius, and Holscher.[1] Internally, it has been employed as an emetic both in adults and children, as a substitute for tartarised antimony. It has also been administered as an expectorant and diaphoretic in catarrh. Externally, it has been applied as a caustic to destroy fungous growths, excrescences, and nævi. A solution of one part of it in ten parts of water has been dropped into the eye twice daily in pustular rheumatic ophthalmia. A solution of it has also been used as a topical application to ulcers, scalled head, and pityriasis versicolor. Bibulous paper soaked in a solution of three drachms of this salt in two ounces of distilled water, dried, rolled into a cylindrical form, and fastened by mucilage, has been employed as a moxa. It developes a strong heat, and is said to burn without requiring to be blown upon. Lastly, a solution of one drachm of the salt in thirty-two ounces of water, has been used as an antiseptic liquor (*liquor conservatrix*) both for living and dead parts.—Dose, as an emetic, from two to four grains for adults; and from a grain to a grain and a half for children. If three grains of it be dissolved in two ounces of water, a table-spoonful may be administered every ten minutes until vomiting is provoked. As an expectorant and alterative, the dose is from an eighth to half of a grain. Externally, it is employed either in the form of powder or in solution: the solution consists of from ℥ss. to ℥iss. of the salt to f℥j. of water.—Antidote, see *Potassæ Bichromas.*

2. Potassæ Bichromas; *Bichromate of Potash; Kali Chromicum rubrum*, $KO,2CrO^3$; Equivalent weight 152.—Obtained by adding sulphuric, nitric, or acetic acid to a solution of the neutral chromate, and setting aside the solution to crystallise. It forms orange-red, anhydrous, quadrangular, prismatic crystals, soluble in 10 parts of cold, and in less of hot water, but insoluble in alcohol. This salt has been used as a source of oxygen Its taste is cooling, bitter, and metallic. Its topical action is that of an irritant and caustic. Its solution irritates the skin. In workmen who habitually employ it, it occasions an eruption of papulæ, which after a little time become pustular; and, if the use of it be continued, the pustules degenerate into sloughs, and painful ulcers are in this way formed.[2] Baer[3] states that troublesome ulcers are produced by it wherever the slightest erosion of the skin exists. Introduced into the stomach, or applied to wounds of animals, it causes vomiting, difficulty of respiration, paralysis, convulsions, and death.[4] In the human subject several fatal cases of poisoning by it have occurred. In some it appeared to kill by its irritant and caustic effects on the stomach and bowels.[5] At other times death has occurred independently of these effects, and from the action of the poison either on the blood or on the nervous system.[6] Toxicological writers usually ascribe it to an action on the nervous system; but the influence of this and other poisons on the blood, as a cause of death, deserves more attention than has hitherto been paid to it. Death by necræmia is, I suspect, of more frequent occurrence than is commonly supposed. Bichromate of potash has been used as an external agent only. Dr. Cumin thinks that if it were cautiously administered internally, "it may be found, like arsenic, to possess considerable tonic virtues." He used a saturated solution of it as an application to tubercular elevations, excrescences, and warts. "In these cases the new growth has sometimes been removed by absorption without any slough; but where a slough has formed, it has always served to expedite the cure, and in no instance have I seen it to be followed by a deep or unmanageable ulceration." In one case it "was the only remedy which acted effectually without causing such intolerable pain as to preclude the continuance of its application." Hauche[7] found it useful for removing syphilitic excrescences without producing scabbing or suppuration. [M. Puche,[8] physician to the Venereal Hospital, has, on the suggestion of M. Bouneau, successfully employed a solution of bichromate of potash as an application to fissures of the mucous membrane, and to syphilitic vegetations. Under its influence the

---

[1] See Dierbach, *Die neuesten Entdeckungen in der Materia Medica*, Bd. i. S. 489, 1837; also Bd. iii. S. 833, 1847. Likewise Aschenbrenner, *Die neuern Arzneimittel*. 1848.

[2] See Dr. Duncan, in the *Edinb. Medical and Surgical Journal*, vol. xxvi. p. 134, 1826; also, Dr. W. Cumin, in the same journal, vol. xxviii. p. 301, 1827.

[3] Quoted by Ducatel, *Journ. of the Philadelphia College*, 1834.

[4] Berndt, *British and Foreign Medical Review*, vol. vii. p. 565, 1839.

[5] Baer, quoted by Ducatel.

[6] Wilson, *London Medical Gazette*, vol. xxxiii. p. 734.

[7] Quoted by Riecke, *Die neuern Arzneimittel*, 1840.

[8] *Bulletin Thérap.* t. xxxix. p. 179; quoted in *Lancet*, 1850, vol. i. p. 147.

vegetations drop off, a
them. The applicatio
administered internall
aggravate all the symp
useful in scrofula and
caustic in the form of
solving from ʒss. to ʒi
saturated solution.—B
tincture of galls, as a
poison. In a case of
either chalk or magnes
water. If vomiting b

ORDER X

Manganese, *Manga*
compounds which hav

97. MANG

HISTORY.—Nati
in the manufacture
but until Kaim, in
was usually regard
or *peroxide of ma*
binoxydum of the
oxydum of the Ed
NATURAL HISTO
macy is the native
It is found in grea
Aberdeenshire, wh
The principal mine
Exeter. The Upt
has yielded scarcely
worked out. Pyro
Silesia, France, an
obtained in the nei
PREPARATION.—
mine, is broken int
separate the earth
palpable powder.
PROPERTIES.—T
pulverulent: the f
variety has someti
colour is iron-blac
varies from 4·7 to
yields a black pow

Characteristics.—When heated, it yields oxygen gas (see OXYGEN). If it be mixed with common salt and sulphuric acid, and the mixture heated, chlorine is evolved. Heated with sulphuric acid, it evolves oxygen, and forms a sulphate of the protoxide of manganese. It is infusible before the blow-pipe, dissolves in fused borax with effervescence, and colours the globule of an amethystine colour. If it be digested in hydrochloric acid until chlorine cease to be evolved, and the solution be slightly supersaturated with ammonia, we get rid of the sesquioxide of iron: the filtered liquid throws down a white precipitate with ferrocyanide of potassium.

COMPOSITION.—Pure binoxide of manganese has the following composition:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Forchammer.*	*Berz. & Arfvedson.*
Manganese	1	28	63·64	63·65	64·02
Oxygen	2	16	36·36	36·35	35·98
Binoxide of Manganese	1	44	100·00	100·00	100·00

PURITY.—The native binoxide is, however, never pure,—it usually contains oxide of iron, carbonate of lime, sulphate of baryta, and argillaceous matter. Its purity is judged of either by the quantity of oxygen which it is capable of yielding, or by the quantity of chlorine set free when this oxide and hydrochloric acid are allowed to act on each other. The quantity of chlorine set free can be estimated by the quantity of protosulphate of iron which it peroxidises.[1] The brown varieties are inferior to the black ones.

Soluble in hydrochloric acid, evolving chlorine.—*Ph. Lond.*

Muriatic acid, aided by heat, dissolves it almost entirely, disengaging chlorine: heat disengages oxygen.—*Ph. Ed.*

PHYSIOLOGICAL EFFECTS.—The effects of this substance are imperfectly known. Kapp[2] regards it as a permanent stimulant, and says it promotes the appetite and digestion. Vogt[3] places it among the tonics, and considers it to be intermediate between iron and lead; but his views are altogether theoretical, as he does not seem to have employed it. Dr. Coupar[4] has described several cases of disease which took place among the men engaged in grinding it at the chemical works of Messrs. Tennant and Co. in Glasgow: from these it appears that, when slowly introduced into the system, it produces paralysis of the motor nerves. The disease commences with symptoms of paraplegia. It differs from the paralysis of lead in not causing colica pictonum or constipation,—and from mercury, in first affecting the lower extremities, and in not exciting tremors of the affected part.

MANGANESIC ACID [Manganic Acid, MnO^3].—Hünefeld[5] gave to a rabbit nearly two drachms of manganesic acid in three days, in doses of ten or fifteen grains. The only obvious effect was increased secretion of urine.[6] The animal being killed, the peritoneum and external coat of the colon were found of a greenish colour [protoxide of manganese is green], the muscles were readily lacerated and pale, the liver was inflamed, the bile increased.

---

[1] Graham. *Elements of Chemistry*, p. 536.

[2] *Hufeland's Journ.* Bd. xix. St. 1, S. 176.

[3] *Pharmakodynamik.*

[4] *Brit. Ann. of Med.* Jan. 13, 1837, p. 41.

[5] Horn's *Archiv f. Med. Erf.* 1830, quoted by Wibmer, *Wirk. d. Arzn.*

[6] [This, if correctly observed, is a remarkable result, since the permanganic acid has been found to diminish the quantity of urine in diabetes.—ED.]

USES.—It is r
ployed in the last
long since observe
not subject to the
were cured by wo
others, to employ
the salts of mang
syphilis. He use
Brera[4] gave it in
administered it in
ployed it in cardi
of old ulcers, as a
and porrigo.[7] K

In chemistry a
manufacture of o
bleacher for the
brown colour com
plate glass; and

ADMINISTRATI
doses varying fro
As a local agent,
three drachms of
of barley-water.
half an ounce or

98. Mang

Manganum Carbon
small quantities in s
Eger), Königswart,
of hydrate by precip
carbonates or bicarb
dried in vacuo over s
air, a portion of the
gives it a brownish
odourless, tasteless
$2(MnO,CO^2)+HO$.
gave six grains of it
from. The animal
changes be detected.

---

[1] Schrodter, V.I.C.A
Jenæ, 1793 (Mérat et
[2] *Ann. de Chimie*, x
[3] Grille et Morelot,
Cutanées, Grenoble, A
[4] Harless, *Neues Jo*
[5] Froriep's *Notizen*,
[6] *Handb. d. pr. Arz*
[7] Rayer, *Treatise on*
[8] Dierbach, *Die neu*
[9] *Die Wirkung der*

[*Saccharine Carbonate of Manganese.*—Dr. Speer,[1] of Cheltenham, suggests the following formula as analogous to that of saccharine carbonate of iron of the last London Pharmacopœia:—Sulphate of Iron, finely powdered, ℥iij. ʒj.; Carbonate of Soda, ℥v.; Sulphate of Manganese, ℥j. ℈j.; White Sugar, ℥iiss. Dissolve each of the three first ingredients in a pint and a half of water; add the solutions, and mix them well; collect the precipitate on a cloth filter, and immediately wash it with cold water; squeeze out as much of the water as possible, and without delay triturate the pulp with the sugar previously reduced to a fine powder. Dry at about 120° Fahr. The salt is of reddish-brown colour, and tastes only of sugar. Dose, gr. v. to ℈j.—ED.]

99. Manganesii Sulphas.—Sulphate of Manganese.

Formula MnO,SO^3. *Equivalent Weight* 76.

Manganum Sulphuricum.—Found in some mineral waters, as those of Cransac in France, and of the Alexisbad in Germany. It may be obtained by dissolving carbonate of manganese in diluted sulphuric acid, filtering and evaporating the solution so as to yield crystals. This salt is extensively used by dyers and calico-printers. A solution of it entirely free from iron is prepared for them "by igniting the peroxide of manganese, mixed with about one-tenth of its weight of pounded coal, in a gas retort. The protoxide thus formed is dissolved in sulphuric acid, with the addition at the end of a little hydrochloric acid; the sulphate is evaporated to dryness, and heated again to redness in the gas retort. The iron is found after ignition in the state of peroxide, and insoluble, the persulphate of iron being decomposed, while the sulphate of manganese is not injured by the temperature of ignition, and remains soluble. The solution is of an amethystine colour, and does not crystallise readily."[2] The anhydrous salt is a white, friable mass, having a bitter, metallic taste, and being soluble in two parts of water at 59°, but insoluble in alcohol. Crystallised sulphate of manganese contains water, the quantity of which varies with the temperature at which the crystals are formed. These, obtained by gentle evaporation at a temperature of from 68° F. to 86° F., consist of $MnO,SO^3,4HO$; those formed between 45° and 68° consist of $MnO,SO^3,5HO$; while those produced below 43° are composed of $MnO,SO^3,7HO$.

C. G. Gmelin[3] tried the effect of the sulphate of the protoxide of manganese on animals, and found that it caused vomiting, paralysis without convulsions, and inflammation of the stomach, small intestines, liver, spleen, and heart. He notices as a remarkable fact, "the extraordinary secretion of bile produced by it, and which was so considerable that nearly all the intestines were coloured yellow by it, and the large intestines had a wax-yellow colour communicated to them." Dr. C. G. Mitscherlich[4] has also examined its effects on animals, and has arrived at the conclusion that it destroys life by its caustic action on the stomach. Unlike alum, tannic acid, and the salts of iron, it does not form insoluble compounds with the constituents of the epithelium, but compounds which are soluble in water, thus acting like potash and soda. In rabbits poisoned by half an ounce of this salt, the mucous membrane was in many places destroyed and dissolved, in consequence of which blood was poured out. Mr. Ure,[5] who tried its effects at my suggestion, found that, in doses of one or two drachms, it acted as a purgative and cholagogue. One drachm of it dissolved in about half a pint of water, and taken in the morning fasting, usually occasions after the lapse of an hour or so one or more liquid bilious stools. Its action is prompt and soon over, and does not occasion the depression which mercurials and antimonials produce in some constitutions. Infusion of senna is a useful adjunct. In some cases sulphate of manganese occasions vomiting and sweating, as well as purging. Sulphate of manganese has been employed in medicine both internally and externally. Ure, Goolden, and Dieterich, administered it as a purgative and cholagogue in torpid states of the liver, in jaundice, and in gout. Kapp used it externally, in the form of ointment, as a substitute for mercurial ointment, in buboes and chancres, and also in chronic cutaneous diseases.

---

[1] *Pharm. Journ.* vol. xiii. p. 330; also *Med. Times and Gazette.*
[2] Graham, *Elements of Chemistry.*
[3] *Versuche über die Wirkungen des Baryts*, &c. 1824.
[4] *Lehrbuch der Arzneimittellehre*, Bd. i. S. 338, 1840.
[5] *London Medical Gazette*, Nov. 1844.

As an alterative, it i
from ʒj. to ʒij. Dr. T
to ℥j. He says he has
of the bowels.[2] Such
used in the form of oin

THE SULPHATED FE
to (see *ante*, p. 307)
chalybeate waters, con
is usually very small.
a grain (0·6538 gr.) of
exception of the Crans
Cransac waters, howev
been analysed by MM.
medicinal springs of th
position is as follows :-

Sulphate of Manganese ..
" the Sesquioxi
" Alumina ....
" Lime ....
" Magnesia....
Black Bituminous Organ
Silica ....
Water......................

From these analyse
tonic, astringent, and
of sulphate of the s
milder waters possess t
smaller proportion of i
larger quantity of sulp

As chalybeates, the
maladies accompanied
conditions of the live
contains, the milder C
of secretion in variou
confined bowels and sl

[The *therapeutical a*
M. Hannon, M. Lanze
beneficially employed i
according to M. Petre
and fill up the lacunæ l
ganese are thus con
they are found combi
easily separated. In l
have been discovered i
cases are not always c
this remedy; in others
occur. In these cases

---

[1] *Chemistry of Inorga*

[2] Dr. Coupar, *Brit. A*

[3] Cransac is a village i
east of Bordeaux, and 80
of Cransac, Lond. 1847).
rupted into Cransac. (A
Doctorat en Médecine, 17

[4] *Journal de Chimie M*

[5] *Bulletin Thérapeutiq*

supplying an element which is deficient, and providing for the reparation and regeneration of the blood.

In answer to the objection that chlorosis is often cured without the use of these salts of manganese, M. Petrequin observes that ferruginous pharmaceutical preparations frequently contain manganese, and further quotes the statement of Soubeiran, that commercial vitriol contains manganese. It has been objected also that the persistence in the use of ferruginous preparations after their administration has ceased to be beneficial only exposes the system to be surcharged with an ingredient of which it does not readily free itself. In M. Petrequin's view, however, the diminution of iron and manganese in chlorotic blood being progressive with the diminution of the globules to the extent of at least one-half, it is erroneous to assert that either the iron or the manganese can ever be in excess in the blood. The analyses of M. Lecanu have shown that the proportion of iron in the hæmatosine remains constant, while the colouring matter of the blood may undergo a decrease by the diminution of the number of globules. As, therefore, these two metals cannot be present in other than their due proportions in the colouring matter of the blood, it is clearly incorrect to administer either of these metals alone to supply the supposed deficiency; M. Petrequin has consequently united the two in therapeutics.

Ferro-manganic salts exert a special effect upon the blood,—on the hæmatosine and liquor sanguinis; they have no tonic or astringent properties. They are, according to M. Petrequin, especially efficacious in chlorosis at puberty, and in the menorrhagic maladies of advanced life; in the anæmic cachexia consequent upon intermittent fevers, in strumous, syphilitic, and cancerous affections, in phthisis, &c. The reparation and restoration of the blood being not merely a chemical but a vital process, dependent upon nervous influence, the ferro-manganic salts are thus found capable of modifying numerous morbid conditions of the nervous system.

The formulæ for the administration of these salts employed by M. Petrequin and many other physicians whom he names, are—

1. Pills of the Carbonate	Ferro-manganic.
2. Pastilles of the Lactate..........	
3. Syrup of the Lactate or Iodide	
4. Chocolate	
5. Gaseous Water	

The doses given by M. Petrequin are small. The proportion of manganese to iron is as 1 to 3.—ED.]

100. Manganesii Chloridum.—Chloride of Manganese.

Formula $MnCl$. *Equivalent Weight* 63·5.

Manganesii Hydrochloras; Muriate of Manganese; Manganum Chloratum.—Occurs in some mineral waters, as those of Karlshaller at Kreuznach. It may be procured by dissolving carbonate of manganese in hydrochloric acid. It is obtained as a secondary product in the manufacture of chlorine from peroxide of manganese and hydrochloric acid. The residuary liquor in this process contains chloride of manganese and perchloride of iron. To separate the latter, first boil down the liquid to drive off the excess of acid. Then dilute with water and add carbonate of manganese, which decomposes the perchloride of iron, precipitates peroxide of iron, and yields chloride of manganese in solution. One-fourth of the impure solution should be reserved to yield, on the addition of carbonate of soda, a sufficient quantity of carbonate of manganese to deprive the remaining three-fourths of the solution of its iron. The purified solution of chloride of manganese yields, on evaporation, rose-red or colourless crystals of the hydrated chloride of manganese, $MnCl,4HO$. If these be gradually heated, the whole of the water is driven off, and the anhydrous chloride remains. It is a rose-coloured, lamellar, deliquescent, inodorous salt, having an astringent saline taste, and being easily soluble both in water and alcohol. Its effects are analogous to those of the sulphate of manganese. It has been employed both externally and internally. In scorbutic affections, and syphilitic ulceration of the mouth and throat, Kapp employed a solution of it as a gargle. Internally it has been employed in chronic cutaneous affections. Osborn gave an alcoholic solution of it internally to repress hemorrhage from the nose. The dose of it is from gr. iij. to gr. x. in watery or

alcoholic solution, in p
pint of water may be
ounce of carbonate of
hydrochloric acid, and
Of this solution from t
giddiness is perceived.
twenty drops may be t

101. Ma

Formul

Manganum Aceticum
in concentrated acetic
Calico-printers procur
$MnO,SO^3+CaO,\bar{A}=$
boidal tables, which ar
It is soluble in 3½ par
Kapp as one of the m
A solution of one scr
gargle in aphthæ.

[102. Potas

This compound has
found to exert a mark
PREPARATION.—Th
hydrate of potash; th
in addition. In the pr
of manganese is ignite
in water, the red solu
place. Wöhler's proc
potash in the state of
crystallisation. Greg
and seven of chlorate
small quantity of wat
spirit lamp; solution
According to Mitsc

K
M

The crystals are s
to gr. xij.[1]
Mr. Sampson,[2] of E
diabetes. A patient,
from ten to twelve pi
symptoms of diabetes
times a day for three
well, and the urine ha
sugar. This improve
siderably increased ab
every other day. Thi
the thirst experienced

From some experiments made by Dr. Odling for Dr. Babington at Guy's Hospital, it would appear that the manganese is excreted with the urine.

In two cases which were under the care of Dr. Basham[1] at the Westminster Hospital, the amount of sugar excreted gradually increased, although the fluid amount of the urine became somewhat less, and the thirst appeared to be alleviated. No inconvenience attended its use; ten-grain doses were taken without any unpleasant effects on the digestive organs: indeed, it was thought that some benefit arose from it, as the fulness and eructations in one case seemed relieved by it. But during its administration the proportion of sugar in the urine gradually increased. This occurred equally in both cases; the symptoms of each differed but little in intensity; there was but a slight discrepancy in their several ages, and in both the disease was unaccompanied by any pulmonary complication, so that there was scarcely room for a doubt that the increased amount of oxygen supplied to the food by the permanganate of potash facilitated the formation of sugar, and did not, as hypothetically inferred, advance the chemical conversion of the glucose into the stage of acid metamorphosis. Further observations are required before the therapeutical value of this substance can be duly estimated.—ED.]

ORDER XX. ARSENIC AND ITS COMPOUNDS.

103. Arsenicum.—Arsenic.

Symbol As. Equivalent Weight 75.

Although metallic arsenic is not used in medicine, yet as it is a poisonous substance (or, at least, acquires poisonous properties), and as, in medico-legal inquiries respecting arsenical poisoning, its production is necessary in order to establish the presence of an arsenical compound, some notice of it here is requisite.

Arsenic is peculiar to the mineral kingdom.[2] It occurs in the metallic state, and in combination with oxygen, with sulphur, and with other metals. There are two native compounds of it with oxygen—namely, *arsenious acid* and *arsenic acid*, the latter being found in combination with bases, forming *arseniates*. Two sulphurets, also, are found native—namely, *orpiment* and *realgar*. It has also been found in some mineral waters.[3]

On the large scale it is obtained by heating mispickel (arsenical pyrites), $FeAs,FeS^2$, in earthen tubes or tubular retorts: metallic arsenic, As, sublimes, leaving behind sulphuret of iron, $2FeS$. On the small scale it is usually obtained by sublimation from a mixture of arsenious acid and charcoal, or of arsenious acid and black flux. The acid is simply deoxidised by the carbon. $2AsO^3+3C=2As+3CO^2$. The potassa of the black flux serves to prevent the volatilisation of the arsenious acid until this has acquired a sufficient temperature for its perfect reduction by the carbon.—Metallic arsenic may also be obtained by heating arsenic acid or a sulphuret of arsenic with black flux: if a sulphuret of arsenic be employed, the products are an alkaline sulphuret, carbonic acid, and metallic arsenic, which sublimes. $2AsS^3+6KO+3C=2As+3CO^2+6KS$.

[The following directions for the preparation of pure arsenic are given in the Appendix to the last edition of the *Dublin* Pharmacopœia:—Take of White Oxide of Arsenic of commerce ʒij. Place the oxide at the sealed end of a hard German glass tube, of about half an inch in diameter and eighteen inches in length, and, having covered it with about eight inches of dry and coarsely-pulverised charcoal, and raised the portion of the tube containing the charcoal to a red heat, let a few ignited coals be placed beneath the oxide, so as to effect its slow sublimation. When this has been accomplished, the metallic arsenic will be found attached to the interior of the tube at its distant or cool extremity.]

---

[1] *Lancet*, Jan. 28, 1854.

[2] The statements of Orfila and Couerbe (*Journ. Chim. Méd.* tom. v. 2e Sér. pp. 462 and 632, 1839; also, *Lond. and Edinb. Phil. Mag.* April 1840), and of Devergie (*Méd. Légale*, 2e édit. t. iii. p. 449), that the bones and muscles of healthy men, as well as the bones of healthy horses, oxen, and sheep, contained arsenic (called *normal arsenic*), have not been confirmed by the experiments of Dr. G. O. Rees (*Guy's Hospital Reports*, xii.), of Danger and Flandin, and of Chevallier (*Journ. Chim. Méd.* t. vii. 2e Sér. p. 84, 1841); of the Commissioners appointed by the French Academy to report on Marsh's apparatus (*Journ. de Pharm.* t. xxvii. p. 428, 1841); of Barbet, Faure, and Magonty (*Ibid.* p. 634), as well as of others. Orfila himself subsequently admitted that he could not procure arsenic from bones (*Traité de Toxicologie*, t. i. p. 438, 1843).

[3] *Journal de Chim. Méd.* tom. v. 2e Ser. p. 183, 1839; *Chemical Gazette*, vol. v. pp. 53 and 334, 1847; and *Répertoire de Pharmacie*, t. iii. p. 176, 1846.

Metallic arsenic is hard, very brittle, and crystalline. The form of its crystal is the rhombohedron. The colour of the metal varies from tin-white to steel-grey. It possesses considerable brilliancy, but soon tarnishes in the air, and becomes dull and dark grey. Sp. gr. 5·6 to 5·9. At a low red heat it volatilises without fusing, and yields a vapour having an alliaceous odour: in the open air this vapour becomes oxidised, and yields white fumes of arsenious acid. The physical characters of the metal differ somewhat, according as this exists in the mass, in the form of a ring lining a glass tube, or in that of a spot on a plate of glass, porcelain, or mica.

Metallic arsenic is recognised by the following characters:—1, its volatility; 2, its conversion into a white volatile powder (arsenious acid) when heated in a tube open at both ends, and held in an inclined position; 3, its conversion into arsenic acid, with the evolution of binoxide of nitrogen gas when it is heated with nitric acid: *a*, when the nitric solution is cautiously evaporated to dryness, and the white solid residue (arsenic acid usually mixed with a small portion of arsenious acid) is touched with a concentrated solution of nitrate of silver, a brick-red arseniate of silver is produced; *β*, and, if another portion of the white residue be dissolved in water, the solution acidulated by hydrochloric acid, and washed sulphuretted hydrogen gas be transmitted through it, a yellow precipitate (*orpiment*) is obtained, which is insoluble in water, but soluble, with decolouration of the liquid, in a solution of ammonia. Metallic arsenic, when swallowed, is capable of acting as a powerful poison,[1] probably by becoming oxidised and converted into arsenious acid.

The substance sold on the continent as *fly-powder* (*poudre aux mouches; Fliegengift*) is essentially metallic arsenic (called *cobalt*, or *cobaltum crystallisatum*) which has become partially oxidised by exposure to the air. It resembles the black or suboxide of arsenic, AsO, and is usually regarded as being a mixture of metallic arsenic and arsenious acid, AsO^3.

104. ACIDUM ARSENIOSUM.—ARSENIOUS ACID.

Formula AsO^3. *Equivalent Weight* 99.

HISTORY.—Arsenious acid (*acidum metallicum sublimatione præparatum*, L.) commonly termed *white arsenic* (*arsenicum album*), or *oxide of arsenic* (*arsenicum oxydum album*), is first distinctly mentioned by Geber,[2] who seems to have been also acquainted with metallic arsenic.[3] Hippocrates[4] employed ἀρρενικόν (*orpiment*) and σανδαράκη (*realgar*) as topical remedies. Dioscorides[5] also mentions ἀρσενικόν (*orpiment*).

NATURAL HISTORY.—Native arsenious acid is found at Andreasberg in the Hartz, at Joachimstahl in Bohemia, and at some few other places. It is a rare mineral.

PREPARATION.—Arsenious acid is prepared in Silesia, Bohemia, Saxony, and Cornwall. At Altenberg, in Silesia, it is obtained from arsenical iron (*mispickel*), composed of sulphur 20·65, iron 35·62, and arsenicum 43·73.[6] After being reduced to powder, the ore is roasted in a muffle furnace (fig. 116), by which the arsenicum is converted into arsenious acid, which is conveyed, in the state of vapour, called *flowers of arsenic*, or *smelting-house smoke* (*Hut-*

---

[1] Orfila, *Journ. de Chim. Méd.* t. v. 2e Sér. p. 3, 1839; and *Traité de Toxicol.* t. i. p. 304, 4me édit. 1843.

[2] *Invent. of Verity*, ch. vii.

[3] *Sum of Perfection*, book i. part iv. chap. ii.

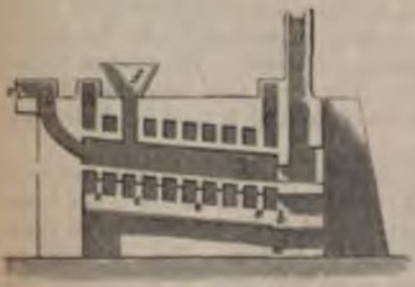
[4] *De Ulceribus.*

[5] Lib. v. chap. xxi.

[6] Dumas, *Traité de Chimie*, t. iv. p. 120.

tenrauch), into the condensing chamber (fig. 117), where it is deposited in a pulverulent form; and in this state it is called *rough arsenious acid*, or *poison-flour* (*Giftmehl*).

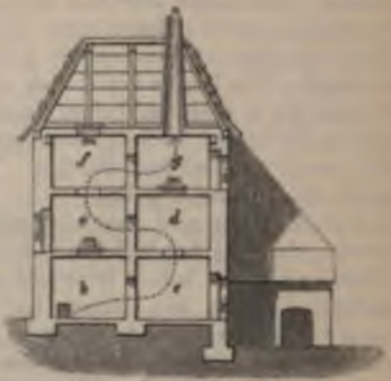
FIG. 116.



Section of the Roasting Furnace.

a. Ash-pit. b. Fire-place. c, c, c. Brick arches for supporting the muffle. e. Earthen muffle for receiving the ore. d. Passage for the fumes into the condensing chamber. f. Hopper for introducing the ore. h, h. Flue. g. Vent for protecting the workmen from the arsenical fumes.

FIG. 117.



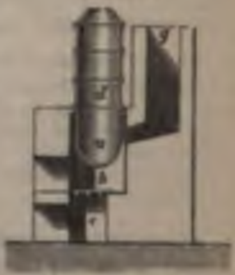
Condensing Chamber.

b, c, d, e, f, g. h. } Course of the vapour.
i, i, i. Doors into the chamber.
m, m, m. Communications between the floors.

The rough acid is refined by sublimation. This is effected in cast-iron pots (fig. 118), to which cylindrical iron heads (*d*) are attached, which at the tops are contracted into cones (*e*), each terminating in a pipe made of sheet iron, and communicating with the condensing chamber (fig. 117). Heat is applied for twelve hours, by which the acid is sublimed and condensed on the sides of the iron head in the form of a glassy mass, called *glacial white arsenic* (*weissen Arsenikglas*), which is sometimes purified by a second or even third sublimation. If it contain any sulphuret of arsenicum, a little potash is mixed with it to prevent the sublimation of the sulphur.

At Reichenstein, arsenious acid is procured from an arseniuret of iron, composed of iron 32·35, arsenic 65·88, and sulphur 1·77. Arsenious acid is procured in some parts of Saxony as a secondary product in the roasting of cobalt ores (the arseniurets of cobalt). It is deposited in long horizontal flues (*poison-flues*, or *Giftfängen*), and is purified by sublimation.[1]

FIG. 118.



Refining Furnace.

c. Ash-pit.
b. Fire-place.
a. Cast-iron pot.
d. Cylindrical head.
g. The chimney.

Arsenious acid is manufactured in Cornwall from the *white mundic* or

---

[1] For further particulars, consult the paper of J. H. Vivian, *Trans. Royal Geol. Society of Cornwall*, i. 60.

mispickel found w
the long horizontal
the use of refiners,
dition it has a grey
masses. The roug
burning-houses in
phur in a common
in length. The hea
the sulphur is dissi
ried on for several
the arsenic remove
weeds, &c. in gard

The arsenious a
kettles, about 2½ f
These kettles are
perforated for an
these kettles are pl
clamped by a flang
heated by a fire be
top aperture, and,
this way introduce
the clamps are the
where the crust is
to neighbouring ve
principally about
eighty-three tons o
Mr. Henwood stat
annually.

[The *Dublin C*
pure arsenious acid

Take of Commerci
a Florence flask, the
size, and, applying
cylindrical hood of
sublime into the *latt*
draught, so as to pro
condensed.]

Properties.—

1. *Crystallise*
that is, it crystalli
isomorphous with

---

[1] Mr. J. Taylor, *An*

[2] *Quarterly Min. Re*
vol. iii. p. 305.

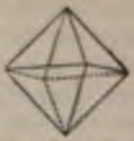
[3] Henwood, in *The*
Falmouth, 1839. Pa
voce, by Mr. Henwood.

[4] For this and some
Wheal Vor tin mine, I

[5] *Transactions of th*

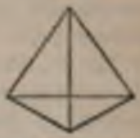
α. *Octohedral arsenious acid.*—This is the usual crystalline form of white arsenic. It may be readily obtained in this form by sublimation (see fig. 121, p. 686), as well as by cooling a boiling saturated aqueous solution. The crystals are transparent, and are usually regular octohedrons (fig. 119), or sometimes tetrahedrons (fig. 120). The conversion of transparent glacial arsenious acid into the opaque, enamel-like acid is probably the passage of the amorphous to the crystalline state.

FIG. 119.



Regular Octohedron.

FIG. 120.



Regular Tetrahedron.

β. *Right rhombic arsenious acid.*—Wöhler found in a cobalt-roasting furnace arsenious acid crystallised in hexahedral plates derived from a right rhombic prism. By sublimation, as well as by solution in hot water, these crystals yielded octohedrons and tetrahedrons.

2. *Amorphous arsenious acid.*—When recently prepared, arsenious acid is in the form of large, glassy, colourless or yellowish transparent cakes (*vitreous* or *glacial arsenious acid*). Frequently the cakes consist of concentric laminæ, formed by successive sublimations. These masses soon become opaque and white externally, like enamel (*opaque* or *enamel-like arsenious acid*), the opacity gradually extending towards the centre; and, in some cases, the acid becomes friable and pulverulent. Krüger[1] ascribes the change to the absorption of water from the atmosphere, for he says it only takes place in moist air, and is attended with an increase of weight, but only to the extent of $\frac{1}{180}$th of the whole mass. Mr. Phillips[2] has taken the same view of the subject. I had some arsenious acid which has remained transparent for more than two years in a glass tube hermetically sealed: the tube was subsequently cracked, and then the acid became opaque. This fact is confirmatory of the opinion just stated.[3] The change from the transparent to the opaque state is by some persons regarded as the transformation from the amorphous to the crystalline condition, the opacity depending on the presence of a multitude of very small crystals. It is remarkable, however, that the density is diminished, while, according to some, the solubility is increased, according to others it is decreased, by this transition.

Professor Guibourt,[4] Mr. Phillips, and Dr. Taylor, have each found the density of the opaque variety to be less than that of the transparent. *Transparent* arsenious acid has a sp. gr. of 3·7391, according to Guibourt (3·715, Phillips; 3·208 to 3·333, Mitchell and Durand; 3·798, Taylor). It dissolves, according to the same authority, in 103 parts of water at 59°, or in 9·33 parts of boiling water, and the solution feebly reddens litmus. *Opaque* arsenious acid, on the other hand, according to Guibourt, has a sp. gr. of 3·695 (3·529, Taylor; 3·620, Phillips), is soluble in 80 parts of water at 59°, or in 7·72 parts of boiling water, and the solution restores the blue colour of reddened litmus; but I find that both kinds redden litmus, and Dr.

---

[1] *Kastn. Arch.* ii. 473, quoted in Gmelin's *Handb. d. Chem.*

[2] *Transl. of the Pharm.* 4th edit.

[3] In the first edition of this work, I stated that arsenious acid became opaque in an air-tight vessel. I have since had reason to believe that the bottle referred to was not completely air-tight, though covered by a varnished bladder.

[4] *Journal de Chimie Méd.* t. ii. p. 57, Paris, 1826.

Christison has obser
in the solubility of t
from a boiling satur
the quantity of acid
without heat. Buss
at 55° F., about th
the various anomalie
mixture of the two
prolonged ebullition
under the influence
verted into opaque a
of importance to k
impairs the solvent
explains why arsenio
contents of the stom
or no taste, as P
neither in the solid
380° F. it volatilises
into a transparent g

Characteristics.-
three heads:—*a.* Th
teristics of a pure
arsenious acid in org

α. **Of Solid Arseni**
(besides its physica
volatility, the garli
cinder, and the qual

1. *Its volatility.*
spirit-lamp, arseniou
If the acid be heate
obtained: the cryst
glass [or by the micr

FIG. 121.

Magnified portion of a T
by the Sublimed Cryst
Arsenious Acid.

---

[1] *Guy*
[2] *Jou*
[3] *Tox*

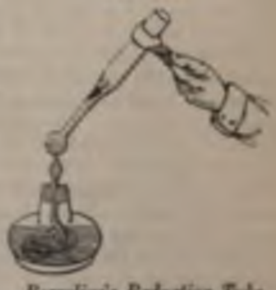
(*arsenious acid*). The deoxidation of the acid is essential to the production of the garlic odour, $2AsO^3+3C=2As+{}^3CO^2$; hence no odour is perceived when arsenious acid is placed on a heated metallic or glass plate, and is not in contact with any organic substance capable of effecting its reduction. The white smoke (arsenious acid) results from the oxidation of the metallic arsenic, $As+O^3=AsO^3$.

The *impediment* to the action of this test is the presence of organic matter (as flour): this, by burning, developes a strong odour, which masks the smell of the vapour of the metallic arsenic.

The *fallacy* attending it is, that some other bodies (as phosphorus, with certain of its compounds and some organic matters) evolve, when heated, a garlic odour. Vauquelin, Barruel, and Orfila, have shown that a compound of albumen and fat, which exhaled this odour when heated, did not contain a particle of arsenious acid. "It is true," say these experimenters, "that arsenicum evolves a garlic odour when volatilised; but even when this is well characterised, it is insufficient to establish the existence of the oxide of arsenic, since it belongs to some other substances; and it is not impossible that there may be developed in the stomach, during digestion, substances which exhale an analogous odour when heated."

3. *Formation of a metallic crust. Reduction test.*—If arsenious acid be intimately mixed with freshly-ignited but cold charcoal, or still better with a mixture of charcoal and carbonate of soda (the residue obtained by incinerating in a covered crucible, tartrate or acetate of soda), and heated in a glass tube, the acid is deoxidised, and yields metallic arsenic, which is sublimed into a cooler portion of the tube, where it condenses and forms a metallic crust: $2AsO^3+3C=2As+3CO^2$. A common cylindrical test tube answers very well: but the reduction tube of Berzelius (fig. 122) is to be preferred. The characters of the arsenical crust (see *ante*, p. 682) are —the brilliancy of its outer surface, which is frequently equal to polished steel or looking-glass; the crystalline appearance and greyish-white colour of its inner surface; its volatility; its conversion, by sublimation up and down the tube, into octohedral crystals of arsenious acid (see fig. 121), which may be dissolved in distilled water, and tested by the liquid reagents presently to be mentioned; and its yielding arsenic acid (AsO^5) by dissolving it in nitric or nitro-hydrochloric acid, and carefully evaporating the solution to dryness. The arsenic acid is known by the red precipitate ($3AgO,AsO^5$, *arseniate of silver*) produced on the addition of nitrate of silver: but if the evaporation has not been carried on sufficiently far, some hydrochloric acid or chlorine will be left, which forms a white precipitate ($AgCl$, *chloride of silver*) with nitrate of silver. The arseniate of silver may be reduced, if necessary, by mixing it with charcoal and boracic acid, and heating it in a glass tube.

FIG. 122.



Berzelius's Reduction Tube.

In some cases the metallic crust is imperfectly formed, or is masked by some decomposed organic matter. Whenever any doubt respecting its nature is entertained, proceed as follows:—Cut off with a file the portion of the tube which contains the suspected crust, roughly powder it, introduce it into another glass tube, and apply heat.

The metallic character of the crust is sometimes rendered more evident by applying to it, for a few seconds, the flame of the spirit-lamp, which drives off a black powder (*black*

or *suboxide of arsenic*, A
long the metal itself sul
arsenic, but less so than
The *fallacies* to whic
an inexperienced exper
students confound a str
the arsenical crust. Ca
cases by the microscope
the inner surface of the
arsenical crust has a cry
limate obtained by red
arsenicum, but by a gla
coalesce by the point of
crusts by oxidating it, a
which can be readily
ought never to be omitte
As a deoxidising ag
arsenious acid into met
useful by preventing th
heated to suffer reduc
these salts is present,
potassium : hence, whe
been recommended; bu
to employ an alkaline fl
the latter attracts wate
mixing bicarbonate of s
the water. [A better
salt may for this purpo
with carbonate of soda
reduced be an arsenite
mixture of charcoal and
sulphurets (as the precip
of arsenious acid) a mix
should be employed. T
$2AsS^3+6(NaO,CO^2)+$
been recommended; as
of soda by Dr. M'Greg
answers very well. N
that of not soiling the
recommended by Dr. C
introduction of the mi
scarcity and greater co

β. **Characters of**
powdered arsenious
part of it floating
lumps at the bottom
times become impor
Poisons, p. 335).
A clear watery so
Its taste is feeble.
crystals (see *ante*,
a yellow colour, and
tate, with sulphuret

---

[1] Griffi
[2] *Hand*
[3] *Lond*

sulphate of copper; a yellow precipitate with ammonio-nitrate of silver; it evolves arseniuretted hydrogen gas when mixed with zinc, and either sulphuric or hydrochloric acid (*Marsh's test*); and lastly, when boiled with hydrochloric acid and clean copper foil, it gives a grey metallic coating to the latter (*Reinsch's test*). These tests require individual notice.

1. *Lime Water.*—Lime water ($CaO + Aq$) occasions a white precipitate (*arsenite of lime*, $2CaO,AsO^3$) with a solution of arsenious acid. The precipitate is soluble in most acids.

The *impediments* to the operation of this test are, a large quantity of water and free acids. which hold it in solution, and gelatinous and oleaginous liquids, which keep it suspended.

The *fallacies* of this test are, carbonates, oxalates, tartrates, and phosphates, which also throw down white precipitates with lime water. On the whole, it is a test of very little value.

2. *Ammonio-sulphate of Copper.*—If a dilute solution of ammonio-sulphate of copper ($CuO,2NH^3,HO,SO^3$) be added to a solution of arsenious acid, a pale green precipitate (*arsenite of copper*, $2CuO,AsO^3$ [?], called *Scheele's green*), soluble both in nitric acid and ammonia, is obtained, and sulphate of ammonia, with excess of ammonia, remains in solution. This test is prepared as follows:—Add (cautiously) liquor ammoniæ to a diluted solution of the sulphate of copper, so as to re-dissolve the oxide of copper, which it at first throws down. Care must be taken not to employ too much alkali, otherwise the test will not act. Moreover, the solution must not be concentrated, or no precipitate will be obtained. This test, though characteristic when cautiously applied, is not very delicate.

The *impediments* to the action of this test are astringents, as tea, infusion of galls, &c. which prevent its acting characteristically.

The *fallacies* to be guarded against are, yellow-coloured and other organic fluids, as decoction of onions, which give a green colour, and slight precipitate (with the *blue* test) even though no arsenic be present.

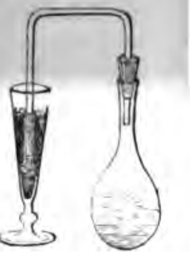
3. *Ammonio-nitrate of Silver: Hume's test.*—If a solution of ammonio-nitrate of silver ($AgO,2NH^3,NO^5$) be added to a solution of arsenious acid, a yellow precipitate (*arsenite of silver*, $2AgO,AsO^3$) takes place, and nitrate of ammonia, with excess of ammonia, remains in solution. The precipitate is soluble in liquid nitric acid, in solution of ammonia, and in solution of nitrate of ammonia. The mode of preparing this test is as follows:—Add a few drops of liquor ammoniæ to a solution of nitrate of silver, so that the oxide of silver which the alkali at first throws down may be nearly, but not entirely, redissolved (see *Solutio Argenti Ammoniati*, E.) Great care is requisite to add neither too much nor too little; for if too much be employed, the solution will not occasion any precipitate with arsenious acid; and if too little, it will produce a precipitate ($3AgO,cPO^5$) with phosphate of soda ($2NaO,HO,cPO^5$), similar in colour to that produced with arsenious acid. The only certain way of knowing when the proper quantity has been employed is to test the solution. Arsenious acid, but not phosphate of soda, ought to occasion a precipitate with it. This test is more delicate than the preceding one.

The *impediments* to the operation of this test are, free acids, (as hydrochloric, nitric, acetic, citric, or tartaric), chlorides, and organic matters. The acids may be readily neutralised by an alkali. If common salt, or other metallic chloride, be present, ammonio-

nitrate of silver throws
a considerable quantity
acid, then an excess of a
chloride of silver, and ap
matter impedes the acti
Ammonio-nitrate of
cipitate with any substa
of that kind. If, howe
tate (*phosphate of silver*,
against which the stude
be added to certain yell
silver) is produced, whi
be mistaken for a yello

4. *Hydrosulphu*
may be employed ei
hydrogen water ; b
If sulphuretted
the liquid is rendere
acid (as of hydrochl
arsenic, or *sulphar*
a solution of arseni
the oxygen of the

Fig. 123.

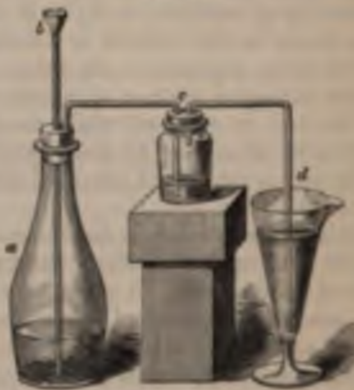


Mode of passing hydro-sulphuric acid through an arsenical solution.

rating it, and thus
that it should be w
to come in contact
is, therefore, to be p
ing the gas are con
funnel *b*. The dis
water contained in t
tion contained in a
The ingredients
iron or antimony)
SULPHURIC ACID.)
preferred. [If the
part of strong sul
evolved by reason

water.—ED.] After the gas has passed through the arsenical liquid for a few minutes, portions of the yellow tersulphuret of arsenic (*orpiment*) begin to fall down. The separation of the precipitate is promoted by ebullition, and the exposure of the solution for a few hours to the air.

FIG. 124.



Apparatus for the Passage of Sulphuretted Hydrogen through an Arsenical Solution.

The essential characters of the precipitate are, its yellow colour, its insolubility in hydrochloric acid, its rapid solution in liquor ammoniæ, forming a colourless and very limpid liquid, and its yielding metallic arsenic when dried and heated with either soda-flux or potash-flux. When the quantity of tersulphuret is small, some difficulty may be experienced in removing it from the filter for reduction. The readiest way is that recommended by Devergie:—Collect it on the filter in as small a space as possible; then wash it with liquor ammoniæ, which dissolves it. The filtered liquid may then be evaporated in a capsule or watch-glass: the ammonia flies off, and leaves the sulphuret.

Hydrosulphuric acid produces yellow precipitates with some other substances, as well as with arsenious acid: and, therefore, the appearance of a yellow precipitate on the application of hydrosulphuric acid does not prove the presence of arsenic.

1. The salts of *cadmium* yield, with hydrosulphuric acid, a yellow precipitate, CdS; but this is insoluble in liquor ammoniæ, and soluble in hydrochloric acid. Cadmium has been detected in some preparations of zinc.[1]

2. *Perchloride of tin*, $SnCl^2$, sold for the use of dyers under the name of *spirit of tin*, yields, with hydrosulphuric acid, a yellow precipitate, SnS^2, which is soluble, though with difficulty, in liquor ammoniæ, and is also soluble in concentrated hydrochloric acid.

A solution of *emetic tartar* ($KO,SbO^3,\bar{T}$) yields, with hydrosulphuric acid, an orange-red precipitate, SbS^3; which is soluble both in liquor ammoniæ and in hydrochloric acid. Dilute solutions of emetic tartar yield paler-coloured precipitates, somewhat resembling those produced in arsenical solutions. If hydrosulphuric acid be transmitted through a liquid in which *pulvis antimonialis* has been boiled, the solution becomes of a reddish yellow colour (SbS^4).

Bihydrosulphate of ammonia, ($NH^3,2HS$) commonly called *hydrosulphuret of ammonia*, is sometimes employed as a substitute for hydrosulphuric acid, an acid being added at the time of employing it, to neutralise the ammonia; but it is liable to several serious objections. When fresh prepared, it causes a yellow precipitate with arsenious acid, red with emetic tartar, and black with solutions of lead; but by exposure to the air for a day or two, it forms a white precipitate with arsenious acid, yellow with emetic tartar, and red with lead!

Bihydrosulphate of ammonia occasions yellow precipitates with the salts of cadmium, bichloride of tin, and emetic tartar, without the addition of an acid, and therefore may be employed to distinguish these metallic salts from arsenious acid, which requires the addition of an acid to enable it to form a yellow precipitate with bihydrosulphate of ammonia.

5. *Nascent hydrogen: Marsh's test.*—If arsenious acid be submitted to the action of nascent hydrogen, obtained by the action of zinc on diluted

---

[1] Vide Thomson's *History of Chemistry*, ii. 220.

sulphuric acid, it is
AsH^3+3HO, and ev
recognised by the foll
burns with a bluish-w
acid) ; 3, its flame de
in the upper part of t
white ring of arsenio
tube heated to dull r
arsenic being deposit
mitted through a sol
are formed in solut
duction of silver ma
paper with a solution
gas.—Ed.]

This process, whi
may be thus applied
diluted sulphuric aci
and pour the mixtur
proper apparatus: b
arsenious acid be pr
arsenic in solution,
taken not to apply a
explosion may be th
characters, which, o
nation :—

α. It has an allia

β. It burns with
($AsH^3+6O=AsO^3$
of common window
be held a short dist
state is deposited on
to cut the flame, an
blackish stain is als
the circumference
arsenic, AsH^2. A
deposited. [The ar
at the circumferen
under similar circu
black and white d
holding vertically o
inches long and a
lined for the space
and the garlic odou
glass funnel may be

In order to prove
the gas was arseniu
obtained, and the liq
the acid, let the flan

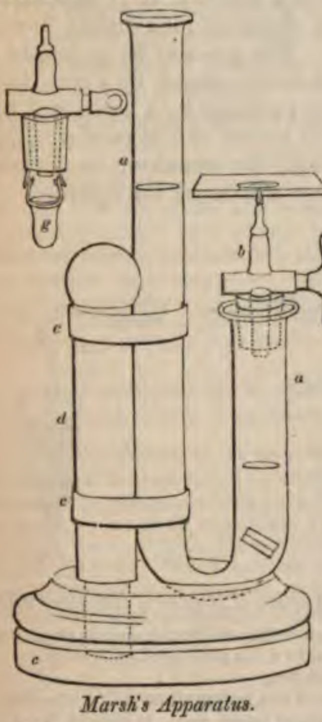
---

[1] *Transactions of th*

placed separately on the under side of the plate of mica; then apply the liquid tests for arsenic before mentioned.[1] Or apply separate drops of the liquid tests themselves to the plate, and then let the flame play on them successively for a few minutes: the characteristic effects of arsenious acid will be obtained. [One mode of procuring the yellow arsenite of silver is to moisten a white saucer with the ammonio-nitrate of silver, and to hold it inverted (*i.e.* with the wetted side downwards) at a sufficient height above the flame to receive and fix the white vapour (arsenious acid) produced by combustion.—ED.]

Various forms of apparatus may be used for this experiment. That employed by Mr. Marsh is a simple glass tube, bent like a syphon (fig. 125). A bit of glass rod is dropped into the shorter leg, then a piece of clean sheet zinc: the stop-cock and jet are afterwards to be inserted. The suspected liquid, mixed with the dilute acid before mentioned, is to be then poured into the long leg. Effervescence is then produced, and after allowing the air to be expelled, the stop-cock is to be closed; and when a sufficient accumulation of gas has taken place, it is again to be opened, and the gas ignited. When the matter to be examined was very small in quantity, Mr. Marsh put the suspected liquid, the acid, and the zinc, in a little glass bucket (fig. 126, *g*), attached to the stop-cock by a platinum

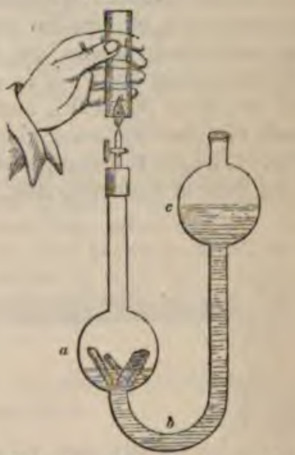
FIG. 126. FIG. 125.



Marsh's Apparatus.

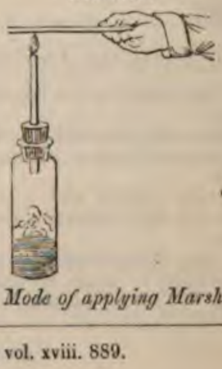
FIG. 125.—*a*. A syphon tube. *b*. Stop-cock. *c*. Wooden block. *d*. The pillar. *e*, *e*. Caoutchouc slips, to fasten the tube to the pillar. *f*. Plate of mica or glass.
FIG. 126.—*g*. Small glass bucket.

FIG 127.



Modification of Marsh's Apparatus.

FIG. 128.



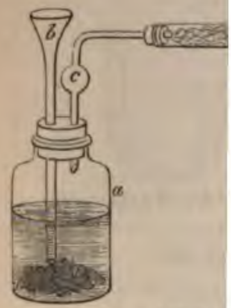
Simple Mode of applying Marsh's Test.

---

[1] Herapath, *London Medical Gazette*, vol. xviii. 889.

wire, and then introdu
common water. When
bell-glass with a stop-c
bell glass is immersed i
apparatus is similar to t
thrown on spongy plati
A modification (fig. 1
each leg of the instrum
thus it enables us to col
frothing by breaking th
But the simplest, che
wide-mouthed phial, wit
It presents this great a
ment, and thus avoid al
vious experiments. [T
a large portion of the a
Dr. Letheby[1] has sug
tional small bulb be blo
break the bubbles or f
prevents the retrogressi

γ. If arseniurette
into arsenicum, or
ring, and into hydro
a double-necked bott
with two holes (fig.
(made of difficultly f
lamp. The gas is d
in the form of a met



Apparatus for subjecting

a. Bottle for generating
drogen.
b. Funnel, or tube, by wh
and arsenical liquor a
bottle.
c. Escape-tube, supplied
dense any liquid whi
bottle.
d. Wider tube, loosely fill
cotton wool] to impe
water. This is not e

The detection of arseniuretted hydrogen by heat was suggested by Liebig,[1] Berzelius,[2] and Chevallier.[3] Some useful and practical improvements in the mode of applying this test were suggested by MM. Kœppelin and Kampmann.[4] The Commissioners appointed by the French Academy introduced some additional modifications of the experiment.[5] The latter recommend that the tube *e* should be coated with gold or silver leaf, and subjected to the heat of a coal fire, which is preferred to the spirit-lamp flame, as it more effectually decomposes the gas. But it complicates the operation, and renders it much more difficult of performance. The arsenicum deposited in the tube may be recognised by its physical and chemical properties before described (see *ante*, p. 682). If the arseniuretted hydrogen be completely decomposed, hydrogen only will be evolved by the extremity of the tube *e*. But as a portion of gas may escape decomposition, the jet should be set fire to, and attempts made to obtain arsenical spots on a plate of porcelain.

3. If the arseniuretted hydrogen be passed through a solution of nitrate of silver, a mutual reaction between these substances is effected. Black metallic flocculi are deposited, and a solution of arsenious acid obtained, mixed with free nitric acid, $6(AgO,NO^5) + AsH^3 = 6Ag + AsO^3 + 3HO + 6NO^5$. Hydrochloric acid is then to be cautiously added to the decanted liquor, to convert the excess of nitrate of silver into the insoluble white chloride of silver. The filtered liquor may then be tested for arsenious acid. Or it may be evaporated to dryness, during which operation the nitric acid oxidises the arsenious acid, and converts it into arsenic acid, AsO^5, which constitutes the dry residuum. This yields a brick-red precipitate, $3AgO,AsO^5$, with a solution of nitrate of silver. The concentrated solution may be transferred to Marsh's apparatus, and thus tested.

This process was suggested by Lassaigne.[6] It has been adopted by the Commissioners appointed by the French Academy.[7] It is a very valuable mode of using Marsh's test, and prevents the loss of the first portions of gas. The apparatus fitted for employing Lassaigne's test has been already described and figured (see *ante*, p. 694, fig. 129, *b*). The black flocculi produced in a solution of nitrate of silver by arseniuretted hydrogen are regarded by Lassaigne as metallic silver, by Graham[8] as arseniuret of silver. It appears to me to be metallic silver contaminated by some intimately adherent arsenious acid, which can be removed by repeated washing and boiling in water, and especially by washing with an alkaline solution.

In the performance of Marsh's test there are several impediments and fallacies, with which the student should be acquainted.

a. The *impediments* to the operation of Marsh's test are, organic liquids (as porter, soup, contents of the stomach, &c.) which occasion great frothing, and choke up the jet. To obviate this, various methods have been advised; such as greasing or oiling the interior of the short leg of the apparatus; putting a layer of alcohol or oil on the surface of the liquid in the short limb, and placing the apparatus aside for an hour or two to allow the bubbles to burst. These methods are all more or less objectionable. They either imperfectly fulfil the object intended, or they mask somewhat the qualities of the arseniuretted hydrogen. The best mode of proceeding in these cases is to remove the arsenic from the liquid by Reinsch's process hereafter noticed (see p. 697). But if it be thought desirable to get rid of the organic matter, the arsenical liquor should be evaporated to dryness, and charred either by heat, very cautiously applied, or by means of oil of vitriol. Danger and

---

[1] *Journal de Pharmacie*, t. xxiii. p. 568.
[2] *Ibid.* t. xxiv. p. 180.
[3] *Journ. de Chim. Méd.* t. v. 2e Sér. 389.
[4] *Journ. de Pharmacie*, t. xxvii. p. 480; *Lond. Med. Gaz.* Aug. 20, 1841.
[5] *Ibid.* t. xxvii. p. 425.
[6] *Journal de Chim. Méd.* t. vii. 2e Sér. p. 638.
Journal de Pharmacie, t. xxvii. p. 425; also, *Lond. Med. Gaz.* Aug. 20, 1841.
[8] *Elements of Chemistry*, p. 635.

Flandin[1] give the following directions for its execution:—Add to the organic matter contained in a porcelain capsule, $\frac{1}{6}$ of its weight of sulphuric acid, and heat until vapours of sulphuric acid appear. The matter is first dissolved, but during the concentration it is charred. The liquor is to be constantly stirred with a glass rod. The carbonisation is effected without any swelling or frothing, and is to be continued until the charcoal is friable and almost dry. A small quantity of concentrated nitric acid or nitro-muriatic acid is to be added by means of a pipette, when the capsule is cold. This converts the arsenious acid into the more soluble arsenic acid. The mixture is then to be evaporated to dryness, treated with boiling water, and the limpid liquor introduced into Marsh's apparatus, in which it never froths. Nitric acid or nitrate of potash is sometimes used to char organic matter; but it is less manageable than sulphuric acid; for towards the end of the experiment it is difficult to prevent deflagration, by which part of the arsenic is lost.

β. The *fallacies* of this test arise from the presence of either antimony or imperfectly charred organic matter in the suspected liquid, or from the employment of either zinc or sulphuric acid contaminated with arsenic. A solution of emetic tartar ($KO,SbO^3,\overline{T}$) placed in Marsh's apparatus (with zinc and dilute sulphuric acid), evolves *antimoniuretted hydrogen gas* (SbH^3). The oxide of antimony contained in the emetic tartar undergoes deoxidation, $KO,SbO^3,\overline{T}+6Zn+6(HO,SO^3)=KO,\overline{T}+6(ZnO,SO^3)+SbH^3+3HO$. Antimoniuretted hydrogen gas agrees in several of its characters with arseniuretted hydrogen.[2] Thus it has a peculiar odour which might be mistaken for that of arseniuretted hydrogen, though it is not alliaceous. It burns in the air with a pale bluish-green flame, and the deposition (on mica, glass, or porcelain) of a black stain (metallic antimony?), which is surrounded by a white one of oxide of antimony (SbO^3). Moreover, the action of hydrosulphuric acid and of ammonio-sulphate of copper on the oxide of antimony produces colours similar to those generated by the action of these tests on arsenious acid. Furthermore, when heated during its passage through a glass tube, antimoniuretted hydrogen is decomposed, and deposits a dark metallic crust. It also occasions a black deposit of antimoniuret of silver in a solution of nitrate of silver, $3(AgO,NO^5)+SbH^3=Ag^3Sb+3NO^6+3HO$.

The antimonial is distinguished from the arsenical crust by the following characters:—First, the dark stain is less bright and metallic than the arsenical one, and, when viewed by transmitted light, is smoky black; whereas that of arsenic is brown. Secondly, if the flame be allowed to play on a solution of ammonio-nitrate of silver, placed on the under surface of a plate of mica, no yellow arsenite of silver is obtained. Thirdly, the greater volatility of arsenicum, and its conversion into octohedral crystals of arsenious acid,[3] may serve, in some cases, to distinguish it from antimony. Fourthly, the solubility of arsenious acid, and the reaction of the before-mentioned liquid tests on the solution, will distinguish it from oxide of antimony, which is insoluble. Fifthly, if antimoniuretted hydrogen be conveyed into a solution of nitrate of silver, no arsenious or arsenic acid can be detected by the tests before directed to be used for arseniuretted hydrogen. Lastly, the metallic crust obtained by submitting a current of the gas to heat presents some distinguishing characters: the arsenical crust is always deposited in the more distant or anterior part of the tube; whereas the antimonial one is first deposited on the heated part of the tube, and by continuing the heat we obtain two rings—one in the anterior or more distant, the other in the posterior or less distant, part of the tube.

In employing Marsh's process, great care must be taken that the process be perfectly clean, and that fresh zinc and acid liquor be used for every experiment. It has been already stated that sulphuric acid frequently contains arsenious acid. The experimenter should also be fully aware of the possibility of the zinc, or even the brass-work of the apparatus, containing minute traces of arsenic; hence the necessity of examining the qualities of the hydrogen flame before adding the suspected arsenical liquid. It has been shown by Mohr[4] that zinc which had been used, but afterwards carefully washed both in water and acid, retained sufficient arsenic to produce the usual effects on the hydrogen flame. Messrs. Danger and Flandin[1] have asserted, and their statements are confirmed by the report of the commissioners of the French Academy,[2] that imperfectly carbonised organic matter introduced into Marsh's apparatus may deposit on glass, or porcelain, crusts which strongly simulate those obtained from arsenical substances. Those non-arsenical spots are composed of sulphite and phosphite of ammonia mixed with a small quantity of organic matter. They dissolve with difficulty in nitric acid; and the residue, obtained by evaporating the nitric solution to dryness, yields, on the addition of nitrate of silver, a yellow precipitate of phosphate of silver. The true arsenical spots, on the other hand, dissolve readily in nitric acid; and the residue obtained by evaporating the nitric solution to dryness forms, with nitrate of silver, a brick-red precipitate of arseniate of silver.

---

[1] *Journal de Pharmacie*, t. xxvii. p. 411-412.

[2] Mr. L. Thomson, *Lond. and Edinb. Phil. Magazine*, May 1837; also Pfaff, *Pharmaceutisches Central-Blatt für* 1838, S. 65.

[3] Dr. E. Turner's *Chemistry*, by W. Turner.

[4] *Journ. de Pharm.* t. xxiii. 563.

6. *Reinsch's process.*—This test was proposed by Reinsch.[3] If an aqueous solution of arsenious acid be boiled with pure hydrochloric acid and clean copper foil, or fine copper gauze, or copper wire, the latter acquires an iron-grey metallic coating of metallic arsenic. $AsO^3 + 3Cu = As + 3CuO$ If the coated copper be washed, dried, cut into small pieces, and then heated in a glass tube by the flame of a spirit lamp, the metallic arsenic is volatilised, and, if the experiment be performed in a tube of very small diameter, it sometimes yields a metallic ring; but in general it becomes oxidised, and yields a sublimate of minute octohedral crystals (AsO^3). If the coating be sufficiently thick, it may be scraped from the copper and heated alone in the tube. The obtained arsenious acid should be dissolved in water and tested with ammonio-nitrate of silver and hydrosulphuric acid (see *ante*, p. 689). Moreover, the solution may be introduced into Marsh's apparatus, and the evolved gas tested as before directed (see *ante*, p. 692).

Dr. Christison recommends that the arsenical solution be mixed with one-tenth of its volume of hydrochloric acid: Dr. Taylor employs one-sixth part. [When the quantity of arsenic is small, and is diffused through much organic matter, the proportion of acid required is larger than under other circumstances.—ED.] The copper may be obtained in foil of any required thinness [but the best form of copper to use is woven copper gauze.—ED.] The time required for the ebullition will vary according to the strength of the arsenical solution. When this is weak, the boiling should be continued for at least half an hour. In conducting this process, care must be taken that the hydrochloric acid be free from arsenic. This may be readily ascertained by boiling it with water and clean copper prior to the addition of the suspected liquor.

Reinsch's process is valuable rather as yielding a ready means of abstracting arsenic from its solution, than as furnishing a new character or test for this substance. When the quantity of arsenious acid contained in the latter is very small, some difficulty may be found in effecting its complete separation from the copper in the form of a distinctly recognisable sublimate. [In this case, the copper-gauze should not be removed until after the lapse of from half an hour to three quarters of an hour. During this time, the liquid should be kept at the boiling point, and pure hydrochloric acid added occasionally to make up for the loss. The copper, although no arsenic be present, will, under these circumstances, often acquire a dull coating (oxychloride). This is known by its being almost entirely removed when the tarnished copper is washed under a current of water. The arsenical deposit has a true metallic lustre, and cannot be removed by mere washing. It varies in tint from a violet blue to a deep iron grey, according to the amount of arsenic deposited. The copper-gauze, when removed from the liquid, should be well washed in water, then in alcohol, and if necessary in ether:—this clears the metal from all traces of organic matter. The gauze, cut up into little slips, rolled into pellets, and introduced successively into a tube of small bore, readily yields, by the aid of a gentle heat slowly applied, a crystalline ring, so minute that it sometimes requires a power of 300 diameters under the microscope to bring out the octohedral crystals: they will then be clearly defined. These crystals may be converted to arsenic acid by nitric acid, and the residue tested by nitrate of silver. For this purpose, the portion of glass holding the sublimate should be detached by the file, broken, and heated with a few drops of nitric acid in a short wide tube by the aid of a sand-bath. The silver test should not be applied until every trace of nitric acid has been expelled.—Ed.]

---

[1] *Journ. de Pharm.* t. xxvii. p. 410.

[2] *Ibid.* p. 428.

[3] *Journ. für praktischen Chemie*, Bd. xxiv. S. 242, 1842.

The *fallacies* of Reinsch's process are, that many liquids will communicate a stain to copper, and some even will cause the formation of a metallic coating. In all cases, therefore, the proof of the presence of arsenic must depend, not on the mere production of a stain or metallic coating, but on the subsequent conversion of this coating into well-marked crystals of arsenious acid; and this must be identified by the characters before mentioned.

Solutions of mercury and silver yield metallic deposits without boiling. Those of tin and lead tarnish the copper, but yield no decided metallic deposit (Dr. Alfred Taylor). Bismuth and antimony are the metals whose solutions yield metallic deposits by Reinsch's process, which most closely resemble that produced by arsenic. "There is one answer to all of these objections; namely, that, from the arsenical deposit, octohedral crystals of arsenious acid may be procured by *slowly* heating the slip of copper, or the grey deposit from it, in the reduction tube. . . . . . If a deposit take place on copper, but crystals of arsenious acid cannot be obtained by heating it, then the evidence of the presence of arsenic is defective."[1]

Dr. Letheby[2] has proposed to substitute zinc for copper, and nitric acid for hydrochloric acid. The metallic arsenic is thrown down on the zinc, which, when mixed with water and sulphuric acid, and placed in Marsh's apparatus, evolves arseniuretted hydrogen.

γ. **Detection of Arsenious Acid contained in, or mixed with, Organic Substances**—I shall confine myself to a brief notice of the modes of detecting arsenious acid when mixed with, or contained in, organic substances, such as articles of food, the contents of the gastro-intestinal tube, the viscera (especially the stomach and liver), the muscles and the urine. For further details, the reader is referred to the valuable works on toxicology of Drs. Christison and Alfred Taylor.

When arsenic is swallowed it becomes absorbed into the blood, circulates through the body, contaminates the various tissues, and is ultimately eliminated (should the patient survive) by the kidneys. Hence, in toxicological investigations, it becomes necessary to submit to examination, not only the solids or liquids in which the poison is suspected to have been administered, and the contents of the stomach and bowels, but also the stomach itself, the liver, the muscles and other animal tissues, the blood, and the urine. In some cases, arsenious acid in the solid state may be readily detected in organic mixtures, and may be picked out or separated by mechanical means. When the stomachs of persons poisoned by this acid are laid open, we sometimes observe the poison in the form of a white powder, or white particles or lumps: these are, of course, to be carefully removed, and if they be arsenious acid, no difficulty will be experienced in recognising them by the test already mentioned (see *ante*, p 686). I on one occasion found about four drachms of solid arsenious acid, in small lumps, in the stomach of a person poisoned by this substance. When the arsenic is contained in solution, the liquid should be separated from insoluble matters, with which it may be mixed, by filtration through a hair-sieve, muslin, cotton, or paper. Oil may be separated from the aqueous liquid by passing the latter through a coarse paper filter previously moistened with water.

---

[1] Dr. Alfred Taylor, *On Poisons*, p. 353-54.

[2] *Pharmaceutical Journal*, vol. v. p. 165, 1845.

Different methods of detecting arsenic in organic matters have been recommended by different writers. It may be said that each has its advantages in particular cases. I shall notice three methods:—

1. *Reinsch's process.*—Arsenic is frequently and with facility extracted from organic mixtures by Reinsch's process. The method of proceeding for simple arsenical liquids has been already described (see *ante*, p. 697). If it be required to extract, by this process, arsenic from solid organic substances (as the stomach, liver, &c.), cut the soft solids into small fragments, and boil them with water acidulated with about one-tenth of hydrochloric acid, until the tissues are all dissolved or broken down into fine flakes or grains. Filter through calico, heat again to the boiling point, and proceed by Reinsch's process as before described.

2. *Marsh's process.*—The difficulty of detecting arsenic in organic liquids by Marsh's process arises from the frothing. Danger and Flandin's method of obviating this has been before described (see *ante*, p 695.) Their process is also applicable to solid organic substances containing arsenic,

3. *Process by hydrosulphuric acid.*—In some cases arsenious acid may be conveniently separated from an organic liquid by passing a stream of hydrosulphuric acid through the liquid previously acidified by hydrochloric acid (see *ante*, p. 690), by which a yellow precipitate of orpiment is obtained. This is then to be reduced in the usual manner by the soda-flux. Organic solids should be cut to pieces, boiled with distilled water, the decoction, when cold, filtered, then acidified with acetic acid, again filtered, evaporated to dryness, re-dissolved in distilled water, and the solution filtered and acidified (if not acid) with hydrochloric acid: sulphuretted hydrogen is then to be transmitted through the liquid. This process is inferior in delicacy to either of the two preceding.

COMPOSITION.—The following is the composition of arsenious acid:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Berzelius.*	*Mitscherlich.*
Arsenicum	1	75	75·76	75·782	75·73
Oxygen	3	24	24·24	24·218	24·27
Arsenious Acid.	1	99	100·00	100·000	100·00

PURITY.—Powdered arsenious acid is sometimes adulterated with chalk or sulphate of lime. The fraud is readily detected by heat, which volatilizes the acid, but leaves the impurities.

White or slightly yellowish; usually opaque, but sometimes also, when freshly broken, more or less translucent. Heated in a glass tube, it is sublimed of a white colour; afterwards, when it is cooled, it is converted into octohedral crystals free from colour. Mixed with charcoal and exposed to heat, it is reduced to arsenic, and it sublimes, yielding an alliaceous odour;[1] afterwards, when it has cooled, it adheres to the tube, shining like a metal. It is dissolved by boiling water, from which, when it has cooled, it falls in octohedral crystals. This solution, when hydrosulphuric acid is added to it, throws down a yellow substance; ammonia, and afterwards nitrate of silver, being added, a lemon-coloured substance; and potash being added, with sulphate of copper, a green substance. If one hundred grains of this acid be boiled in dilute hydrochloric acid, and, when the solution has cooled, hydrosulphuric acid be mixed with it, one hundred and twenty-four grains of tersulphuret of arsenic are precipitated.—*Ph. L.*

---

[1] [The alliaceous odour is due to the metallic arsenic, which condenses on the sides of the tube forming the metallic coating alluded to in the text.—ED.]

The *Edinburgh College* merely observes, that arsenious acid "is entirely sublimed by heat."

PHYSIOLOGICAL EFFECTS. α. *On Vegetables.*—The effects of arsenious acid on plants have been studied by Jäger,[1] Marcet, Macaire,[2] and by others, and from their observations we learn that it is poisonous to all the higher, and most of the lower, families of plants. It appears that seeds which have been soaked in a very strong solution of arsenious acid are incapable of germinating, and that buds which have been plunged in it are no longer capable of expanding. [Arsenic in a weak solution exerts no injurious effect on the germination of seeds, while it destroys the spores of many parasitic fungi. It is thus frequently employed in the steeping of corn.—ED.] If roots or stems be immersed in this solution, the plants perish; death being preceded by drooping of the leaves and petals, and the appearance of brownish patches on the leaves, the veins and midribs of which are discoloured. If the stem of the common barberry (*Berberis vulgaris*) be placed in a solution of arsenious acid, the plant dies, but the stamens, according to Macaire, become stiff, hard, and retracted, and on any attempts being made to alter their position, they readily break. On repeating the experiment, however, I did not observe this condition of the stamens. I found them not at all brittle, but quite flexible, and difficult to break by the point of a knife. The leaves, when burnt, evolved a garlic odour. Jäger also found that arsenic is absorbed by plants; for, on burning vegetables destroyed by this poison, he experienced, as I have done, an alliaceous odour.

On some cryptogamic plants, arsenious acid appears to have no injurious influence. Jäger has seen a small plant (supposed by De Candolle[3] to be *Mucor imperceptibilis*) growing in water which contained $\frac{1}{32}$ of its weight of arsenic. And more recently, Gilgenkrantz[4] says he has seen an algaceous plant, of the genus either *Leptomitus* or *Hygrocrocis*, develope itself in a solution of arsenic. I can confirm his statement. I have on one occasion observed an abundant vegetation (*Hygrocrocis?*) in a solution of arsenious acid, the vegetable filaments being intermixed with octohedral crystals of arsenic. These are most remarkable exceptions to the general effects of this poison on vegetables, and deserve further examination.

β. *On Animals generally.*—Arsenious acid is poisonous to all classes of animals. No exceptions, I believe, are known to exist to this statement. The most extensive series of experiments on this subject are those performed by Jäger.[5] From them we learn, that in all animals, from the infusoria up to man, death from arsenic is invariably preceded by inordinate actions and increased evacuations, especially from the mucous membranes. In most animals the stools were frequent and fluid; and in those in which mucus is secreted on the surface, it was remarkably increased. The power of voluntary motion and susceptibility of external stimuli were decreased; and after death the muscles soon ceased to be influenced by the galvanic agency. In animals which breathe by lungs, respiration became difficult and laborious; and in warm-blooded animals great thirst was experienced. In birds and mammals convulsions came on, preceded by vomiting, except in those animals (as the rabbit) which cannot vomit. Enormous quantities of arsenious acid have been sometimes administered to horses with impunity. Berthe[1] gave two, and afterwards three, drachms to a mare, for the cure of an obstinate skin disease, without any injurious effects. Beissenhirz[2] gave successively, on different days, one, four, three, two, and eight drachms of arsenious acid to a horse: the animal did not die until the ninth day after taking the last-mentioned dose. Yet, notwithstanding these and some other analogous facts, which seem to prove that arsenic has comparatively little effect on horses, the best-informed veterinarians agree in considering it an energetic poison to these animals.[3]

---

[1] *Diss. Inaug.* Tubingæ, 1808; quoted by Marx, in his *Die Lehre von den Giften,* ii. 99.

[2] *Mém. de la Soc. de Phys. et d'Hist. Nat. Genève,* t. iii.

[3] *Phys. Vég.* p. 1329.

[4] *Journ. de Pharm.* xxiii. 38.

[5] *Op. cit.*

γ. On Man. αα. Of very small or *therapeutical doses.*—In very small quantities (as one-sixteenth or one-twelfth of a grain) no obvious effects are usually produced by the use of arsenic, unless it be continued for a long period. Indeed, some writers[4] go so far as to assert that it is a strengthening remedy, and that it improves the appetite, invigorates digestion, promotes assimilation and secretion, excites the muscular and nervous functions,—in a word, acts as a *tonic.* I cannot, however, subscribe to this doctrine. It is, indeed, true that patients sometimes experience a temporary increase of appetite from the use of small doses of arsenic; and it is also certain that this remedy is frequently beneficial in agues and other diseases in which tonics have been found efficacious. But the analogy between the action of arsenious acid and that of the vegetable tonics, as cinchona (to which Vogt compares it), stops here. I have sought in vain for other evidences of a tonic operation. I have seen very minute doses of arsenic given to patients affected with lepra, and continued for many days, without being able to detect the least indication of its action on the system, except the amelioration of the disease. When the dose was slightly increased, the appetite in some cases appeared to be increased; but the effect was neither universal nor continued. Very shortly afterwards, a sensation of heat in the throat, œsophagus, and stomach, came on, occasionally with nausea, but seldom with vomiting; in a few cases with gastrodynia, a febrile condition of the body was set up; there were dryness of the skin, increased secretion of urine, relaxed bowels, sometimes with griping; the patients usually complain of great languor, inaptitude for employment, and want of sleep; and sometimes these symptoms were accompanied with, or followed by, pricking or irritation of the tarsi, redness of the eyes, a slight degree of conjunctivitis, and certain swellings, especially of the face (*œdema arsenicalis*)—effects which are so different from those produced by the remedies called strengthening, that I cannot regard arsenic as a tonic. In proof of the beneficial effects of this substance, we are gravely told that the country-people of Upper Styria, in Austria, use arsenic as a stomachic and condiment for many kinds of food—for example, cheese; and a healthy peasant himself tells us, that he was accustomed to take two grains of arsenic daily, without which, he assures us, he could not live![1] In further proof of this strengthening action of arsenic, Vogt says that it promotes the appetite, the activity, and the power of old enfeebled horses, and mentions that Jäger noticed the same effects on a pigeon. To the first of these statements, namely, the beneficial effects from the use of arsenic as a condiment, I do not give credence,[2] and, with respect to the action of arsenic on horses, every well-informed veterinarian knows that this substance operates on these animals as a poison.[3]

---

[1] *Recueil de Méd. Vét.* Oct. 1825.

[2] Quoted by Wibmer, *Die Wirkung,* &c. i. 317.

[3] See the evidence of Mr. Bowles, in the *Edinb. Med. and Surg. Journ.* viii. 351.

[4] Vogt, *Pharmakodynamik.*

Dr. Fowler[4] gives the following summary of the effects of the arsenical solution in more than 320 cases:—In about one-third no operation: "somewhat more than one-third were attended with nausea; and nearly one-third with an open body; and about one-third with griping. Vomiting, purgings, swellings, and anorexia, were but rare in comparison with the preceding effects, and their less frequent occurrence was generally found in the order in which they are here enumerated, swellings and anorexia being the seldomest. About one-fifth of the cases were attended with nausea, and one-quarter of those attended with an open body were unconnected with any other effects. Griping did not often occur alone; purging and anorexia seldom or never; and vomiting was always accompanied with more or less nausea." There are several effects produced by medicinal doses of arsenic which Dr. Fowler has overlooked. The most important of these are the irritation of the conjunctiva and swelling of the face. As soon as these occur, the arsenic should be either suspended or given in reduced doses. Mr. Hunt[1] states that in persons of fair complexion and delicate skin, arsenic commonly produces a dirt-brown, dingy, unwashed appearance of all those parts of the body protected from the access of light and air. He says that, when examined under a lens, there is found to exist a delicate desquamation of the skin; in fact, a faint form of pityriasis. In some cases salivation has been produced by the medicinal use of arsenic, as will be noticed presently.

---

[1] *Med. Jahrb. d. österr. Staates*, 1822, i. 96, quoted from Wibmer.

[2] [This absurd and incredible statement regarding the nutritious and beneficial properties of arsenic has been lately revived and placed in an attractive form before the public by an English chemist. (*Chemistry of Common Life*, No. X. *The Poisons we Select*. By J. F. W. Johnston, M.A., F.R.S., &c.) The question however is not one of chemistry, but of physiology and pathology; and in this point of view the so-called "undisputed facts" regarding the benefits derived from arsenic-eating have been rejected by all authorities of repute, including the author of this work. The publication of such a statement, unconfirmed as it is by those who have had large and ample experience on the subject of poisoning with arsenic, is only likely to be productive of great mischief. It may lead persons to take the course suggested in this pamphlet, and endeavour to fatten their children upon a substance which must ultimately destroy them: it may justify burial-club-murders, by inducing the public to believe that arsenic is given to infants not to kill them, but to improve their appearance, and, in the words of the writer, "to lessen the natural waste of the body." Lastly, we may find that ingenious barristers, in defending prisoners, will adopt the author's theory in a case of alleged criminal poisoning of a woman by her paramour,—that arsenic has been given merely "as a love-awakener—the harbinger of happiness—the soother of ardent longings—the bestower of contentment and peace!" (*The Poisons we Select*, No. X. p. 208.) It would have been much more satisfactory to the public and profession, and a good proof of the author's sincere belief in the truth of these Styrian tales, had he in the first instance tried the effects of a few doses.—ED.]

[3] [The question regarding the action of arsenic on horses arose at a recent trial for murder. It was suggested that it was a useful and beneficial medicine. It is undoubtedly a poison to these animals, and we have had several horses' stomachs to examine, in which arsenic had clearly been the cause of death. A distinguished professor at the Veterinary College informs us that, although some farriers employ arsenic in small doses to improve the condition of the skin of these animals, it is an unsafe medicine, and its use is generally discountenanced by modern veterinarians. Mr. Morton, lecturer on veterinary materia medica at the Royal Veterinary College, makes the following observations regarding the employment of arsenic:—"As a therapeutic agent for the horse, arsenious acid can be well dispensed with. It is, however, employed by some as a tonic, being given in doses of from ten to twenty grains daily, and by others as a vermifuge. When injudiciously administered death has been the result; the whole of the abdominal viscera being in a state of inflammation, and the lining membrane of the stomach and intestines being eroded in patches. By those of the old school it is extolled as a caustic, and a very powerful one doubtlessly it is; but there is this disadvantage attending its use,—we cannot control its action, and oftentimes a most extensive and painful wound is caused by it. Occasionally it is resorted to for the eradication of warts, although a better plan is to extirpate them at once by the knife. When, however, this is inadmissible, one part of arsenious acid, in a state of fine powder, may be intimately fixed with four parts of lard, and a portion of the compound applied with friction over and around the excrescences every other day, for three or four times. This will excite such powerful sloughing action, that in about ten days the warts will be thrown off." (*Manual of Pharmacy*, p. 52.)—ED.]

[4] *Medical Reports of the Effects of Arsenic*, p. 98, Lond. 1786.

β. Of long-continued small doses, or of large medicinal doses (slow or chronic poisoning).—Small doses of arsenious acid, continued for a long period, act as a slow poison; and, if persevered in, will ultimately occasion death. The same effects take place, in a shorter period, from the administration of large medicinal doses. Sometimes the digestive apparatus, at other times the nervous system, first shews symptoms of the poisonous operation of this agent. Hahnemann (quoted by Dr. Christison) has graphically described the condition of slow poisoning by arsenic as "a gradual sinking of the powers of life, without any violent symptom,—a nameless feeling of illness, failure of the strength, an aversion to food and drink, and all the other enjoyments of life."

On some occasions, the first symptoms which I have observed of its poisonous operation have been thirst, redness of the conjunctiva and eyelids, followed by a cutaneous eruption. At other times, irritation of the stomach is the leading symptom. In some cases ptyalism is brought on. Marcus[2] noticed this effect; as also Dr. Ferriar.[3] Mr. Furley[4] has published five illustrative cases of it. Trousseau and Pidoux[5] also mention this symptom as produced by the long-continued use of feeble doses of arsenic. Another instance of this effect has been published by Mr. Jones.[6] This effect acquired some importance in the celebrated Bristol case of poisoning.[7]

The following is an abstract of the symptoms produced by the long-continued employment of small doses of arsenious acid, but which are more or less modified in different cases:—Disorder of the digestive functions, characterised by flatulence, sensation of warmth, or actual pain, in the stomach and bowels; loss of appetite; thirst, nausea, and vomiting; purging, or at least a relaxed condition of the bowels, and griping; furred tongue, with dryness and tightness of the mouth and throat, or with salivation. Quick, small, and sometimes irregular, pulse; oppressed respiration, with a dry cough. The body wastes—the stomach being frequently so irritable that no food can be retained in it. Headache, giddiness, and want of sleep, are frequently observed. The limbs become painful, feeble, trembling, subject to convulsions; occasion-

---

[1] *Practical Observations on the Pathology and Treatment of certain Diseases of the Skin generally pronounced Intractable*, p. 15, Lond. 1847.

[2] *Ephemeriden*, 1809.

[3] *Med. Hist. and Refl.* iii. 306.

[4] *Lond. Med. Gaz.* xvi.

[5] *Traité de Thérap.* ii. 148.

[6] *Lond. Med. Gaz.* xxvi. 266.

[7] *Ibid.* xv. 519; and *Trans. Prov. Assoc.* iii. 432.

ally benumbed, and ul
cases, affected, an erup
and nails fall off. S
observed; and under
cases retaining his co
stupor supervening.

γ. *Of excessive or*
produced by the ingest
alike, but put on three
are those indicating ga
or at least only slight
are absent, and the pri
nervous systems. La
enteritic symptoms, wi

Form 1*st*: *Acute poiso*
poisoning, nausea and vo
are attended with burnin
whole abdomen. Pain a
vomited vary in their
tinged with blood. Fre
tion of the throat, acco
hydrophobic difficulty of
comes affected, indicated
hard and tense condition
bloody), by the tenesmu
the lower part of the ali
becomes affected; and t
pain in the genital organ
The constitutional symp
local disorder: thus the
there are cold clammy s
tion; the breathing is
and the membrane lining
this form of acute arse
cases, almost the only a
of disorder of the cerebr
of the limbs, or deliriu
eruptions take place.

In this form of poison
after the administration
where death occurred in

Form 2d: *Acute pois*
of gastro-enteritis.—In s
are those indicating dis
vomiting, and purging,
usually faintness, or pe
sometimes, insensibility
In most of the recorde
example, half an ounce
The individual (a gentle
acid, and swallowed it.
drachms of the poison.
depression of the vasc
His intellect was clear
There were neither con
poison from the stomac
nistered, and the stoma

found more than four drachms of solid arsenious acid, in the form of lumps, in the stomach after death. Their weight had apparently prevented their removal during life.

Form 3d: Acute poisoning with symptoms of gastro-enteritis, followed by an affection of the cerebro-spinal system.—In this form of poisoning we have at first the usual gastro-enteritic symptoms, which I have already described under the first form of poisoning. When, from the smallness of the dose, or from other circumstances, the patient recovers from gastro-enteritis, symptoms of a cerebro-spinal affection sometimes make their appearance. The kind of disorder, however, varies considerably in different individuals. "The most formidable," says Dr. Christison, "is coma; the slightest, a peculiar imperfect palsy of the arms or legs, resembling what is occasioned by the poison of lead; and between these extremes have been observed epileptic fits, or tetanus, or an affection resembling hysteria, or madness."

In a medico-legal point of view, it is important to determine *what is the smallest fatal dose of arsenious acid.*[1] It is not easy, however, to give a positive answer to this question. Dr. Christison says, "the smallest actually fatal dose I have hitherto found recorded is 4½ grains. The subject was a child four years old, and death occurred in six hours. In this instance, however, the poison was taken in solution." Dr. Letheby[2] has reported a case in which two grains and a half proved fatal in 36 hours: the patient was a robust girl. More recently, a case has been recorded[3] in which there was reason to suspect that the death of a woman was produced by half an ounce of Fowler's mineral solution (=2 grs. of arsenious acid). The powerful effects sometimes produced by $\frac{1}{8}$, $\frac{1}{4}$, or $\frac{1}{2}$ a grain, lead us to suspect that one grain *might* produce death; but we have no recorded case of this. Hahnemann says, one or two grains may prove fatal in a few days; and Dr. Christison remarks that this statement cannot be very wide of the truth. Of course a *repetition* of much smaller quantities might cause death. Dr. Alfred Taylor considers that from two to three grains may be regarded as a fatal dose. However, under certain circumstances, enormous quantities have been swallowed with very trivial effects. Some years ago I opened the body of a man who destroyed himself by taking arsenic, and I was informed by the friends that about a fortnight previous to his death he made an attempt to destroy himself by swallowing a quantity of powdered arsenic, which they found, on inquiry at the druggist's of whom it was purchased, to have weighed half an ounce. It was taken immediately after dinner, and the only effect produced was violent vomiting. Here it is evident that the distension of the stomach with food saved the patient's life. This unfortunate individual repeated the attempt, and death was the result. Another remarkable case of recovery, after the ingestion of half an ounce, has been recorded by Dr. Skillman.[4]

MORBID APPEARANCES PRODUCED BY ARSENIOUS ACID.—When arsenious acid kills by its narcotic operation (constituting the second form of arsenical poisoning), no morbid condition is observable after death. In other cases, however, various alterations are observed, which may be most conveniently arranged under the following heads:—

a. Morbid appearances of the alimentary canal.—The alterations observed in the condition of the intestinal canal vary with the quantity of the poison taken, and probably with other circumstances, but they are all indicative of inflammation: thus we have redness as one symptom, sometimes accompanied with extravasations of blood into the tissue of the canal; ulceration is also occasionally observed, sometimes softening of the mucous coat, effusion (of lymph or blood), and occasionally even gangrenous spots.

---

[1] See some remarks on this subject by Dr. A. S. Taylor, in the *Guy's Hospital Reports*, No. xii. also in his work *On Poisons*.

[2] *Lond. Med. Gaz.* vol. xxxix. p. 116, Jan. 15, 1847.

[3] *Ibid.* vol. xlii. p. 87, July 14, 1848.

[4] *Ibid.* vol. xix. p. 238, from *American Journ. of Med. Sciences*, Aug. 1836.

β. *Morbid appearances of the vascular system.*—The blood is sometimes, though not invariably, fluid after death, and dark coloured. The heart is mostly flabby, and it is asserted that on its inner surface (especially the carneæ columnæ and valves, particularly of the left side), is observed redness, sometimes diffused, sometimes in the form of spots,[1] which penetrate a line in depth into the substance of the heart. The pericardium usually contains serum.

γ. *Morbid appearances of the respiratory system.*—These are neither very remarkable nor constant, and principally consist in redness of the pleura, effusion of lymph or serum into the cavity of the pleura, red spots, and occasional congestion of the lungs, and redness of the membrane lining the air-tubes.

δ. The *morbid appearances of other parts* deserve little attention. In some cases, inflammation, and even gangrene, of the *genital* organs have been observed; the *conjunctiva* is sometimes very vascular, and alterations are occasionally observed in the condition of the *skin*. Redness, extravasation of blood, and effusion of serum, are said to have been seen in the *brain*.

In connection with the morbid appearances produced by arsenic, the following remarks, made by Orfila,[2] deserve notice:—Under certain circumstances, the mucous membrane of the stomach and intestines is lined with a multitude of brilliant points, composed of fat and albumen: placed on burning coals, these grains decrepitate on drying, and produce a noise which has been improperly denominated *detonation:* they inflame as a fatty body when they contain a notable quantity of fat, and exhale an odour of burned animal matter. These *fatty* and *albuminous* globules may be met with in the bodies of individuals who have not been poisoned, and require attentiye examination in order to distinguish them from arsenious acid. The best method of avoiding this error is to digest these granular parts with water, and to apply the tests proper for demonstrating the existence of arsenious acid."

Influence of Arsenious Acid on the Putrefactive Process.—Until the commencement of the present century it was supposed that the bodies of animals poisoned by arsenious acid were unusually prone to putrefaction. This, however, has been satisfactorily disproved by the experiments and observations of Klank, Kelch, Hünefield, and others;[3] and it appears that, when placed in contact with animal textures, it acts as an antiseptic. "I have kept a bit of ox's stomach four years in a solution of arsenic," says Dr. Christison, "and, except slight shrivelling and whitening, I could not observe any change produced in it." This antiseptic property of arsenious acid, which has been, in my opinion, fully and satisfactorily proved, sufficiently accounts for the good state of preservation in which the alimentary canal has been frequently found some months after death in those poisoned by this acid, where it was not evacuated by vomiting or purging.[1]

---

[1] White spots are frequently met with on the surface of the heart when no arsenic has been taken (*Guy's Hospital Reports*, vol. iii.)

[2] *Dict. de Méd.* éd. 2, art. *Arsenic.*

[3] Quoted by Wibmer, in his *Wirkung d. Arzneim. u. Gifte;* and by Dr. Christison, in his *Treatise on Poisons.*

But there is another effect said to be produced on the bodies of animals, which is not so easily accounted for: I mean their conversion into a kind of mummy-like or adipocerous matter. The following is an abstract of the phenomena, as deduced from numerous experiments and observations, several of which are recorded in Dr. Christison's invaluable *Treatise on Poisons*. After death putrefaction commences, and is attended with the usual odour; but, instead of increasing in the customary manner, it seems for a time to be at a stand-still, and then a series of changes commences of a peculiar character: the soft parts become firmer and drier, at the same time retaining their structure; the putrid odour is frequently succeeded by one resembling garlic; the skin becomes brown and parchment-like; the muscular fibres and cellular tissues (especially of the abdominal parietes) are changed into a tallowy cheesy-like mass; the liver, spleen, and heart become dry, while the bowels, lungs, and brain, form a greasy mass. During these processes the quantity of arsenic in the body diminishes, probably by exhalation,—a circumstance very probable, when we bear in mind the garlic odour emitted by the body, and which has been observed by several writers. The diminution, however, must be exceedingly small. After some time the cheesy smell disappears, and the body becomes dry and hard. In some cases the alimentary tube has been found little changed or decomposed, although other parts of the body had been completely mummified. Some writers do not ascribe these phenomena to the influence of arsenious acid, but to other causes. Jager[2] tells us that in his experiments the putrefaction of the bodies of animals poisoned by arsenic seemed neither to be retarded nor hastened, whether they were buried or not; but he admits that parts in contact with an arsenical solution seem preserved from putrefaction.[3] Seemann[4] likewise states, that the bodies of three dogs underwent the same kind of putrefaction after death. However, that in many cases arsenic modifies the putrefactive process, can hardly, I think, be doubted by those who carefully examine the evidence adduced in favour of this opinion.

Does this mummifying process depend on the chemical influence of the arsenic, or ought we to refer it to a change effected by arsenic on the body, during life, causing "a different disposition and affinity among the ultimate elements of organised matter, and so altering the operation of physical laws in it?" The latter hypothesis appears to me untenable; for, in the first place, there is no evidence of any peculiar change of this kind during life;

---

[1] In the dissecting-room of the London Hospital it has been observed that subjects injected with arsenious acid were but little decomposed at the expiration of one or two months, even during the summer season. But the skin acquired a dark colour, and the body underwent a remarkable change, which some persons compared to a kind of gelatinisation. Arseniuretted hydrogen appears to be evolved. The bones of these subjects were impregnated with arsenic; and black and yellow deposits (the former, perhaps, of metallic arsenic, the latter, of orpiment) were very obvious in the skeletons. The use of arsenical injections is objectionable, on account of the troublesome sores which bodies so preserved give rise to in those engaged in dissection.

[2] Quoted by Wibmer, *op. cit.* i. 305.

[3] [On the 5th September, 1854, we placed an egg previously deprived of its shell by diluted acetic acid in a cold saturated solution of arsenious acid. Although exposed in a laboratory to temperatures varying from 60° to 70°, it had not undergone the slightest change on the 5th October following. The albumen was only separated from the arsenical solution by the thin outer membrane, and the vessel was exposed to the air.—ED.]

[4] Quoted by Christison, *op. cit.* p. 372; also Wibmer, *op. cit.* i. 322.

secondly, that this do
process commencing
culiar influence of th
until this process has
by the body. It is,
detected in the body
probably that the qu
recognise: and it is
new combinations w
probably in a gaseou
notion, as well as th
the body diminishes

MODUS OPERANDI
to a living surface,
longer a matter of d
animal tissues (liver,
Although Beissenhir
(stomach, cæcum, lu
substance, yet to O
facts, and applied th
purposes it is useful
tity in the liver, sple
infiltrated pleura of

Arsenious acid ap
the body, especially
That the *alimentar*
tion of the stomac
which, according to
when this poison is
specifically acted on
at the præcordia, an
appearances (red sp
susceptibility to the
system is inferred fr
dering pains, impai
ness, lassitude, trem
The alimentary can
which this acid app
and the salivary gl
lungs is inferred
appearances after de
skin, and the fallin
to the idea of the s
—an opinion which
fluence it exercises i
noticed by Marcus,

---

[1] *De Arsenici effica*
Arzneimittel. u. Gifte, B
and *Traité de Toxicologi*
in the *Journ. de Pharm.*

[2] *Lond. Med. and Ph*

salivary glands are specifically influenced. The swelling of the face, and the irritation and redness of the eyelids, also deserve notice in connection with the specific effects of this poison. On the whole, it is impossible, I conceive, in the present state of our knowledge, to designate the medicinal effect of arsenic by any term which shall briefly but characteristically declare its physiological properties. The terms *tonic* and *antispasmodic* are quite insufficient for the purpose; nor am I satisfied with the designation *antispasmodic spanæmic* before given to it.

[There is equal difficulty in accounting for the operation of this mineral as a *poison*. The facts hitherto ascertained are, that arsenic passes with greater or less rapidity into the blood by absorption; that it is circulated through all parts of the system; temporarily deposited in the solids (soft organs), and constantly eliminated by the fluids so long as life continues. In addition to the parts mentioned by the author in which arsenic has been found after death, we may state that it has been detected in the liquor pericardii, in the bile, in the amniotic fluid of pregnant females, in the placenta, in the structures of the fœtus in utero, and in the parasitic worms which are found in the intestinal canal. In cases of recovery, the process of elimination continues until the body is cleared of the poison; and, in reference to *absorbed arsenic*, this clearance is presumed to take place in from two to three weeks after the removal by absorption of the last portions of poison.

The blood, therefore, is clearly poisoned; but does this throw any light upon the cause of death? The proportions and properties of the constituents of the blood are unaltered. We have repeatedly submitted arsenical blood to a microscopical examination. The corpuscles have presented a normal appearance in shape and size; and, in fact, assuming that the vital properties of the blood have undergone an alteration by the presence of this poison, so as to render it no longer fitted to maintain life, *that* alteration cannot be detected either by the most refined chemical analysis, or by the most delicate microscopical research. In short, the *modus operandi* of arsenic is as inscrutable as that of the poison of cholera, small-pox, or other zymotic diseases.

An hypothesis has been put forward in recent times, to the effect that arsenic acts as a poison by entering into a definite *chemical* combination with albumen and muscular tissue, forming such stable compounds as the *vis vitæ* is unable to break up, and therefore (?) the vital functions are destroyed. The meaning of this appears to be, that arsenic enters into a close chemical union with the albumen and fibrin of the body, and that the arsenicated organic compounds thus formed are not so well adapted for the maintenance of life as those which are unarsenicated. This, however, is a mere evasion of the physiological difficulty. Assuming that such arsenicated compounds are formed in the tissues of the liver, spleen, and heart, the physiological problem is really to determine how and in what manner the functions of life are arrested by such a chemical union of this poison with the soft solids. The chemical hypothesis above mentioned is one of those in which words are substituted for sense. A person who has taken arsenic may die from sudden syncope; the heart may yield traces of arsenic; but how does this throw any light upon the sudden suspension of its functions? for the same quantity of arsenic may be found in the heart in another case, in which death has been preceded by coma—a suspension of the functions of the brain. In short, admitting the supposed definite chemical combination with the tissues to

exist, there is not th
tion has any direct i
to the extent of sayi
dered unfitted to sus

The basis upon w
being satisfactorily es
with the view of sustai
conclusion that arse
with albumen or mu
extent: by its viscid
which are undissolve
cases of arsenical poi
other action on arse
a chemical kind. T
Brett, Mr. Edwards,
that there is no com
substances.[1]

The chemical hyp
us, therefore, to be
for an hour, or a d
elimination of truth
confusion:' but, abo
tation they offer; or,
them as established.'

Uses.—So powerf
with great caution,
for it has upon more
agent.

In *intermittent*
employed with great
in this country, we
Lemery and Wepfer
Dr. Fowler was led t
of the "*Tasteless*
that this patent medi
by Dr. Fowler, of the
by himself, by Dr. A
by the subsequent ex
been more successful
a stop to the disease
Dr. Brown,[5] who has

---

[1] See *Pharmaceutical J*
[2] Faraday, *Lecture on*
[3] *Medical Report of the*
[4] [Arsenic appears to ha
Report of the Chinese Hos
which is said to have been
arsenic placed in an orange
lised, but a portion of oxid
loosely stated; but the fact
(*Pharmaceutical Journal,*
[5] *Cyclopædia of Practic*

manently ill effect arise from it; he considers it superior to crude bark, but inferior to quina: over both it has the advantages of cheapness and tastelessness. It should be given three times a day. It is not necessary to intermit its use during the febrile paroxysm, for I have repeatedly seen it given with the best effects during the attack. In agues accompanied with inflammatory conditions, in which cinchona and sulphate of quina are apt to disagree, arsenic may, according to Dr. Brown, be sometimes administered with the best effects. It is also very successful in relapses after the use of the above remedies. Dr. Macculloch states, that one-sixteenth of a grain of white arsenic, given three or four times a day, will sometimes cure ague when the *liquor potassæ arsenitis* fails.

[Some trials have been recently made in order to determine the comparative value of arsenic and quina in the treatment of this disease.

M. Maillot[1] has observed the results of the administration of arsenic in one hundred and sixty-six cases, against a comparative series of forty-two cases in which quinine was given. The conclusions arrived at by M. Maillot are:—That arsenious acid is not so certain in its action, as a febrifuge, as sulphate of quinine; that the latter has never failed to effect a cure; that it has been successfully employed where the arsenious acid has been exhibited without success;—that the effect of quinine is more prompt than that of arsenic. With the latter, the fever recurred in one half of the cases, while in the cases treated with quinine the recurrence only amounted to one-fourth. It was observed, however, that distant relapses were less frequent, and after longer intervals, in those to whom arsenic had been given.

M. Andral[2] has observed the effects of arsenic in eleven cases, and places it next in value to quinine. According to him, it should never be employed except in those cases in which quinine has failed to do good.

M. Gibert[3] considers that its virtues have been much overrated, as regards diseases of the skin.

M. Girbal[4] has observed the effects of arsenious acid in fifty-one cases, and has stated his results to be the same as those already recorded, viz. that, although possessing a considerable remedial power over agues, more especially tertian agues, yet it is a less prompt and less certain remedy than sulphate of quinine.—ED.]

A combination of arsenic and cinchona, or arsenic and sulphate of quina, sometimes succeeds, where these agents used separately fail. When the stomach is very irritable, opium is occasionally advantageously conjoined with arsenic. If the bowels be confined during the use of the remedy, gentle laxatives should be employed. Arsenic has been beneficially employed in various other periodical diseases; as in periodical headaches and intermittent neuralgias.

In various *chronic affections of the skin*, particularly the scaly diseases (lepra, psoriasis, and pityriasis), eczema, and impetigo, arsenic is one of our most valuable agents. I can confidently recommend it in lepra, having seen a large number of cases benefited by it. Frequently the disease is relieved without any obvious constitutional effect: sometimes a febrile condition of

---

[1] *Medical Gazette*, vol. xlvi. p. 687.
[2] *Ibid.* vol. xlviii. p. 478.
[3] *Ibid.* vol. xlvi. p. 687.
[4] *Bulletin Thérap.* t. xliv. p. 128.

the body is brought
occasionally with a
secretion are often p
occasionally, as I ha
complain of swelling
use of the medicine
ease returns at the e
on a return to the u
it frequently fails t
have been benefited
According to M
fluence" over non-sy
failures in the treatn
sources:—1st, the s
the administration o
disease; 3dly, the r
the remedy in too la
five minims of Fowl
as the conjunctivitis
ployment of gradua
which I have usually
value of arsenic in
ascribe to it the "al
for I have repeatedly
these maladies,[1] espe
eczema.

[**Mr. Hunt** has lai
tion of arsenic in th
guide to those inclin
the most important c

"With the subjoi
more or less readily t
lations:—

"1. Functional ir
deficient, or suppress
on established princi
tion is directed to
arsenic may be tried
seldom excites diarrh

"2. The pulse an
standard, must be re

"3. These prelimi
well as it were sponta

"4. There are cert
in a short time, but t
(*a*.) The chief of the
and alkalies, sulphur

---

[1] For further information
eases of the Skin, by Dr. W

and sarsaparilla. (*b.*) External applications and baths of every kind fall under the same category: they may relieve, but do not cure.

"5. Arsenic is not open to these objections. It is not only curative, but preventive. It rectifies the peculiar *cachexy* on which these diseases depend. (*a.*) Arsenic is a *safe* medicine, provided it be administered with ordinary caution, on the plan herein described. (*b.*) It is also a pleasant medicine, being without either taste or odour; and is, perhaps, the only medicine which patients could be induced to take for two or three years together, as is sometimes necessary.

"6. Fowler's solution of arsenic (its purity having been previously tested) may be administered in doses of five minims three times a day, with or after the meals, in a little water. (*a.*) The dose should never be dropped from the lips of the vial, nor yet measured undiluted. The only way to secure accuracy is to dilute the solution with distilled water, and then measure a corresponding quantity in a minim measure; thus — ℞ Liquor Potassæ Arsenitis, ʒj.; Aquæ Destillatæ, ʒvij. M. Capiat minima xl. ter in die.

"7. If the conjunctiva or the tarsi become inflamed, reduce the dose, and so regulate it if possible that the eyelids shall continue slightly tender through the whole course. The dose very rarely requires to be increased. (*a.*) The state of the conjunctiva may always be allowed to regulate the dose; for, of the other inconveniences arising apparently from the use of small doses of arsenic, one half exist only in the imagination of the patient, and the other half may be due to other causes. (*b.*) Colicky pains, diarrhœa, cough, coryza, insomnia, incubus, palpitatio, nervous tremors, and many other unpleasant effects, are often attributed to the use of arsenic; but these are seldom complained of by patients who take it *unawares*. The usual effects are improved appetite, warmer limbs from improved circulation, increase of strength and spirits, a more regular action of the bowels, and an improved tone of the whole system. (*c.*) These results must be confessed to be exceedingly various in different individuals, and even in the same individual at different times.

"8. When inflammatory action *supervenes* in an arsenical course, it is better to combat it by local depletion than to suspend the arsenic; nevertheless, if febrile action persist, the arsenic must be laid aside for a time.

"Neither plethora nor anæmia forbids the use of arsenic: but the former must be regulated by a strict diet, and the latter by a generous one, with tonics if necessary.

"The arsenical course must be protracted (in reduced doses) for about as many *months* after the final disappearance of the disease as are equivalent to the number of *years* it had previously existed. This will generally prevent a relapse.

"11. The curative powers of arsenic reside in doses too small to be mischievous. Therefore, individuals who appear to be peculiarly susceptible or even intolerant of the ordinary doses, may be nevertheless cured by adapting the dose to the constitution of the patient.

"12. These principles of treatment are applicable to all chronic diseases of the skin, excepting only those which are contagious in their primary forms, as scabies, porrigo, and syphilis."—ED.]

Various chronic affections of the nervous system have been treated by the arsenious acid, and with occasional benefit: for example, neuralgia,

epilepsy, chorea,[1] and
number of epileptic ca
fits occurred less freq
medicine. In chorea,
know of no remedy fo
tion of cases, acts alm
[M. Debout[2] employs
It is said to possess th
head.[3]

In bites of venom
been recommended.
acid) has long been ce
and other venomous
posing that it possess
employed as an intern
tism, especially when
bones, particularly ve
in the last stage of *ty*

Arsenious acid has
has been applied and
high authorities; but
a celebrated surgeon
18 years of age, on a
the cicatrix had been
panied with darting p
actual cautery, he app
in diameter. Colic, v
next day; and in two
am convinced," says
I could quote several
tent myself with referr
following case, related
externally, even when
with an arsenical oint
fectly sound, the hea
became twice their nat
parts of the head; th
tumefied, and almost
the tongue parched,

---

[1] Dr. Gregory, *Med.-Chir.*
[2] *Bulletin Thérap.* t. xxxv
[3] *Edinb. Med. and Surg.*
[4] Colhoun and Baer, *Amer*
[5] Ferriar, *Med. Hist.* i. 84
[6] *Nouv. Elém. de Méd.*
[7] *Die Wirkung*, &c.
[8] [In a case which was the
the application of an arsenical
preparation used contained o
only *one* night on a surface o
these circumstances, death wi
[9] Orfila's *Toxicol. Général*

pain, and a sensation of great heat. Vertigo, fainting, cardialgia, occasional vomiting, ardor urinæ, constipation, trembling of the limbs, and delirium, were also present. In a day or two after, the body, and especially the hands and feet, were covered with a considerable eruption of small pimples with white heads. She finally recovered, but during her convalescence the hair fell off.

Though employed as a caustic, yet the nature of its chemical influence on the animal tissues is unknown. Hence it is termed by some a *dynamical* caustic, in opposition to those caustics acting by known chemical agencies. Mr. Blackadder[1] asserts, that the danger of employing arsenic consists in not applying a sufficient quantity. A small quantity, he says, becomes absorbed, whereas a large quantity quickly destroys the organisation of the part, and stops absorption. Arsenic has been extolled as a remedy for *cancer*. Justamond[2] esteemed it a specific. Various empirical compounds, which gained temporary notoriety in the treatment of this affection, owe their activity either to arsenious acid or the tersulphuret of arsenic. But by the best surgeons of the present day it is never employed, because experience has fully shown that it is incapable of curing genuine cancer, while it endangers the lives of the unfortunate patients. It cannot, however, be denied, that diseases resembling cancer have been much relieved, if not cured, by it, and that the progress of cancer itself has occasionally been somewhat checked by its use. [Arsenical injections in cancer of the uterus have been employed by Mr. Lloyd[3] at St. Bartholomew's, for the purpose of preventing fœtor. These are said to succeed better than other disinfectants (?), as they exert a sanatory influence upon the ulcerative surface, and prevent the fœtid discharge. The solution employed is from two to eight grains of arsenious acid in one pint of water.—ED.]

In some forms of severe and unmanageable ulceration, especially *lupus* or *noli me tangere*, arsenical applications are employed with occasional benefit, where all other local remedies fail. In such cases, arsenic is not to be regarded as a mere caustic; for other and far more powerful agents of this kind are generally useless. It must act by substitution: that is, it sets up a new action in the part, incompatible with that of the disease. The late Baron Dupuytren employed an arsenical dusting powder (composed of 99 parts of calomel and 1 part arsenious acid) in lupus, not as an escharotic, but rather as a specific. Mixed with gum-water, or with fatty matters, it has been sometimes used as a paste or ointment. These applications are to be allowed to fall off spontaneously, and to be repeated five or six times. Sir A. Cooper[4] recommends an arsenical ointment (arsenious acid, sublimed sulphur, aa. ʒj.; spermaceti cerate, ℥j.) to be applied, on lint, for twenty-four hours, and then to be removed. When the slough comes away, the ulcer is to be dressed with simple ointment, and will generally heal in a short time. Cazenave says he has seen arsenical applications used by Biett, and has himself employed them many times, without having met with one instance of injurious consequences. The arsenical paste (arsenious acid, cinnabar and burnt leather, made into a paste with saliva or gum-water) is used when a powerful action is required; but besides the danger of causing constitutional symptoms to which all arsenical compounds

---

[1] *Observations on Phagedena Gangrenosa*, Edinb. 1818.

[2] *An Account of the Methods pursued in the Treatment of Cancerous and Scirrhous Disorders, and other Ulcerations*, Lond. 1780.

[3] *Med. Times and Gazette*, July 1, 1854.

Lancet, i. 264.

are liable, it is apt to
regards an arsenical
spermaceti ointment,
arsenic has been succ
gerous and at first a p
tic is placed in the ho
in one case it caused

Arsenious acid is a
tories.

ADMINISTRATION.—
doses of from one-si
crumb of bread. In
the arsenic be equally
a mortar with some fi
much safer mode of
solution with potash (
mentioned, that Dr.
solution: and Dr. Ph
rently, and cannot be
(*De Valangin's solu*

Whether given in
ately after a meal, wh
an empty stomach (as
casion gastric disorder
to enable the stomach
stitutions, tonics may b
or a laxative (as rhub
or the bowels confined
any unpleasant sympt
of the eyelids, dryness
appearance, it will of
a few days the use of t
it is not proper to co
its employment for a
consequences resultin

ANTIDOTES.—In c
to be fulfilled:—

1. The first object
For this purpose the
be not in readiness, a
a feather or the finger
phate of zinc. Prom
white of egg and wat
tea, oil and lime-wate
liquid serves to prom
casein, or sugar,) in
mechanical antidotes
solubility of the arsen

To expel arsenious acid from the intestines, castor oil is the best purgative.

2. The second object is *the employment of mechanical and chemical antidotes*. The uses of mechanical antidotes in cases of poisoning have been already noticed. The demulcents directed to be used in promoting vomiting are, in fact, mechanical antidotes. Charcoal, magnesia, hydrated sesquioxide of iron, and any inert powder (as linseed-meal, flour, or liquorice-powder), when swallowed in large quantities, may be occasionally of service, by enveloping the particles of arsenic, and preventing their contact with the gastric surface. Olive oil, on which, according to Dr. Paris,[1] the Cornish miners rely with confidence, can only act mechanically in the way just mentioned.

Of chemical antidotes (see *ante*, p. 164), there are none for arsenic on which much reliance can be placed. Those recommended are:—animal charcoal, hydrated sesquioxide of iron, magnesia, and lime-water. But none of these are efficacious as chemical agents unless the poison be in solution. Now, as arsenic is almost invariably taken in a solid form, it follows that the benefit which may be obtained by the use of these agents is generally to be ascribed to their action as mechanical antidotes. With respect to the hydrated sesquioxide of iron, Dr. Maclagan[2] observes, that, "as far as chemical evidence goes, at least twelve parts of oxide, prepared by ammonia, and moist, are required for each part of arsenic." It should be stated for "each part of arsenic in solution," as it only acts chemically on the *solution*. But, as we cannot usually determine how much has been swallowed, Dr. T. R. Beck[3] recommends that we should administer to an adult a table-spoonful at least, and to children a dessert-spoonful, every five or ten minutes, until relief from the urgent symptoms is obtained. (For further details, see the article *Ferri Sesquioxydum hydratum*.) Highly-calcined magnesia has been lately revived by Bussy as a chemical antidote for arsenic. When in the gelatinous or hydrated state, it abstracts arsenious acid from its solution by forming with it a difficultly-soluble arsenite of magnesia.[4] In conclusion I may observe, that no objection whatever can be raised to the use either of hydrated sesquioxide of iron or of magnesia as antidotes:—neither of them can do harm; both of them certainly are useful as mechanical antidotes: they may be serviceable as chemical antidotes. [A mixture of magnesia and persulphate of iron may be usefully exhibited on these occasions, taking care that the magnesia is in excess.—ED.]

3. Another indication is the use of *dynamical antidotes*, or *counter-poisons*,—agents which are supposed to neutralise or counteract the effects of the poison. Unfortunately we have here no specifics; and the treatment must be conducted on general principles. When the gastro-enteritis is marked, antiphlogistic measures have been resorted to; such as blood-letting. Moreover, so long as the poison is in the stomach, this operation is objectionable, on the ground of its promoting absorption. Opium is a very valuable agent. Indeed, Jäger seems to regard it in the light of a counter-poison. However, on this point he has probably taken a too exaggerated view of its efficacy: but it

---

[1] *Pharmacologia.*

[2] *Edinb. Med. and Surg. Journ.* No. 144.

[3] Dr. T. R. Beck, *Lond. Med. Gaz.* Oct. 15, 1841.

[4] For further details regarding the action of hydrated sesquioxide of iron and magnesia as antidotes for arsenical poisoning, the reader is referred to Dr. A. Taylor's work *On Poisons*, pp. 86 and 89.

is undeniable that on
ject it, we may employ
mus be troublesome, r
When there is much c
sometimes requisite.

4. The last indicati
of the poison from t
Orfila recommends th
water, and nitrate of p
the use of purgatives,
antidotes (calcined ma
second absorption.

1. LIQUOR POTASS
Liquor Arsenicalis,
(Arsenious Acid [bro
Potash, each grs. lxx
Water, Oj. Boil the
pint of the water in a
pound tincture of la
distilled water, as muc
measure, *L. E.*)—The
stronger: the proport
Carbonate of Potash,
Spirit of Lavender, f℥
duce the arsenious aci
a pint of water, and b
cooled add to it the c
will make the bulk of
tion is 1013· *D.*)—[
formulæ of *London* a
formula of *Dublin* co
tion the arsenious acid
gages the carbonic
excess of carbonate is
colouring and flavouri
according to the Lond
of arsenious acid. Th
and cautiously increas
three times a day for a
has given from 15 to
some persons are pecu
always to commence w
even pregnant women
only six weeks old, aff
the following table of d

Ages.	*Doses.*
From 2 to 4 years	from 2 or 3 to 5 drops.
" 5 " 7 "	" 5 " 7 "
" 8 " 12 "	" 7 " 10 "
" 13 " 18 "	" 10 " 12 "
" 18, and upwards	12 "

But it may be remarked, that the quantities here indicated are larger than it will be safe, in most cases, to commence with. Half an ounce taken in the space of five days is supposed to have caused death (see *ante*, p. 705).

[Mr. Lloyd Bullock,[1] in some remarks on the *liquor arsenicalis*, observes that the uncertainty of the pharmacopœial preparations is due to the indefinite nature of the compound. According to Mr. Bullock's analysis, the officinal solution consists of arsenious acid dissolved in carbonate of potassa, with a minute quantity of arsenite of potassa, as noticed by Soubeiran alone, before himself. Mr. Bullock suggests the following formula for the preparation of a neutral arsenite of potash:—Take 80 grains of arsenious acid, and 67·5 grains of carbonate of potassa, *Ph. L.*, or 81·6 grains of crystallised bicarbonate of potash. Boil in ten ounces of water until no more carbonic acid is evolved. When cold, make up to exactly twenty ounces with distilled water, and, if thought desirable, a small quantity of a distilled spirit. Mr. Bullock regrets the omission from the last Dublin Pharmacopœia of the binarseniate of potassa, which he observes is a beautiful salt, easily prepared, and keeps well. The arseniate of soda is, in his opinion, the most certain and the most convenient form, for medicinal purposes, of all the preparations of arsenic, as it possesses great solubility, definite form, and is readily made into pills.—ED.]

2. LIQUOR ARSENICI CHLORIDI, L.; *Hydrochloric Solution of Arsenious Acid; De Valangin's Solutio Solventis Mineralis; Phillips's Solution of Chloride of Arsenic.* (Take of Arsenious Acid, broken into fragments, ℥ss.; Hydrochloric Acid, f℥iss.; Distilled Water, Oj. Boil the arsenious acid with the hydrochloric acid, mixed with an ounce (fluidounce) of the water, until it is dissolved; then add as much water as may be requisite to exactly fill a pint measure.

The late Dr. De Valangin[3] introduced the *solutio solventis mineralis* into medical use. He prepared it by subliming in a bolt-head a mixture of 3 lbs. of arsenious acid and 8 lbs. of common salt. The sublimate was a white powder, which he called the *solvent mineral*. This was dissolved in diluted hydrochloric acid, and formed his *solution of the solvent mineral*, which by some persons has been regarded as a *solution of chloride of arsenic*. He presented the Apothecaries' Company with a quantity of his preparation, as well as with the formula for its manufacture. In submitting a mixture of arsenious acid and common salt to sublimation, no chemical change is effected. The arsenious acid sublimes unaltered. De Valangin's *solvent mineral* is in reality, therefore, nothing but this acid; and, provided pure arsenious acid be

---

[1] *Pharm. Journ.*, 1850-51, p. 357.

[2] *Philadelphia Journ. of Med. and Phys. Sc.* xiv. 187.

[3] Dr. Franciscus Josephus Pahud de Valangin was a native of Switzerland; but practised in London. He died in 1805. A short sketch of his life, with his portrait, is given in the *European Magazine* for 1805. (See also the *Gentleman's Magazine* for the same year.) He was the author of *A Treatise on Diet, or the Management of Human Life by Physicians*, Lond. 1768.

employed, the process
that he has submitted
to microscopic exami
crystals of arsenious

By dissolving arse
either of the *terhydr*
arsenic. $AsO^3 + 3$
solution contains terch
the distilled product
that the quantity of
residual liquor in the

De Valangin's sol
to any other preparati
acquainted with it, ki
of chorea which resist
"by the late Dr. Bat

Although I have
I have not hitherto
of potash, which cur
chorea and lepra whi
apt to disturb the st
separation of the ars
secretion. Before its
the bases (soda of t
canal. It is probabl
passes into the blood

One fluidounce of
given, contains only
quantity of Fowler's
therefore, that the r
symptoms under the
quantity of arsenic u
daily. Dr. Farre tel
a day, and, after a fe
In this way he procee
gastric disorder supe
sequently renewed in

Butter of arsenic
caustic in cancer and
employed it in cance
grains of calomel ha

---

[1] *Journ. de Pharmacie*,
[2] Dr. Bateman (*Practic*
Fowler's solution in the t
by the late Dr. De Valan
mineralis, and is equally e
[3] *Anleit. zu d. Krebscu*
S. 768, 1830).
[4] Hufeland's *Journal*,

3. ARSENICI ET HYDRARGYRI HYDRIODATIS LIQUOR, D.; *Solution of Arsenic and Mercury.* (Take of Pure Arsenic, in fine powder, grs. vj.; Pure Mercury, grs. xvj.; Pure Iodine, grs. lss.; Alcohol, fʒss.; Distilled Water, ℥ix., or a sufficient quantity. Rub together the arsenic, mercury, iodine, and spirit, until a dry mass is obtained; and, having triturated eight ounces of the water with this in successive portions, let the whole be transferred to a flask, and heated until it begins to boil. When cooled and filtered, let as much distilled water be added to it as will make the bulk of the solution exactly eight fluid ounces and six drachms.)

4. PILULÆ ASIATICÆ; *Asiatic Pills.*[1]—(Arsenious Acid, gr. lv.; Powdered Black Pepper, ʒix.; Gum Arabic, a sufficient quantity to make 800 pills, each of which contains about $\frac{1}{15}$ of a grain of arsenious acid.)—These pills are employed in the East for the cure of syphilis and elephantiasis.

5. UNGUENTUM ARSENICI; *Arsenical Ointment.*—An ointment containing arsenious acid is used of different strengths by surgeons. For onychia maligna I have already mentioned one containing two grains of arsenic to an ounce of lard or spermaceti ointment. The *Ceratum Arsenici* of the United States Pharmacopœia consists of Arsenious Acid, in very fine powder, ℈j.; Simple Cerate, ℥j. This is used as a dressing for cancerous sores, but must be applied with great circumspection (see another formula at p. 715).

6. PASTA ARSENICALIS; *Arsenical Paste.*—Various formulæ for this are given. The *Pulvis Escharotica Arsenicalis* (*Poudre caustique du frère Cosme ou de Rousselot*) of the French Codex is composed of finely levigated Cinnabar, 16 *parts*; powdered Dragon's Blood, 16 *parts*; finely levigated Arsenious Acid, 8 *parts*. Mix intimately. At the time of employing it, it is made into a paste, by means of a little saliva or mucilage. This preparation is employed to cauterise cancerous wounds. It must be used very cautiously, and applied to limited portions only of the ulcerated surface. I have already referred to its occasional dangerous or fatal effects (see *ante*, p. 714). It deserves especial notice, that this officinal preparation of the French Codex is very considerably stronger than was used either by Rousselot or Cosme, notwithstanding that it is named after them.[2]

105. Arsenici Sulphureta.—Sulphurets of Arsenic.

No fewer than seven compounds of sulphur and arsenic are noticed by L. Gmelin.[3] Of these, two only require to be noticed here.

Arsenici Bisulphuretum; *Bisulphuret of Arsenic; Risigallum; Realgar; Red Sulphuret of Arsenic; Red Arsenic; Sandaraca, σανδαράχη; Sandarach.*—It occurs in the

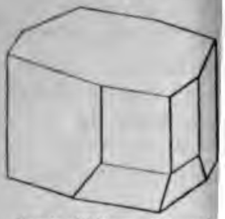
---

[1] *Asiatic Researches*, vol. ii. p. 153. The formula for these pills, given in the text, is that usually followed (Rayer, *Treatise on Skin Diseases*, by Willis, p. 1215). The original recipe is very indefinite: one tola [105 grs.] of arsenic and six times as much black pepper are to be made into pills "as large as tares or small pulse."

[2] For further information respecting arsenical paste, see Patrix, *L'Art d'appliquer la Pâte Arsenicale*, 8vo. Paris, 1816.

[3] *Handbuch d. Chemie*, Bd. ii. 1844.

Fig. 130.

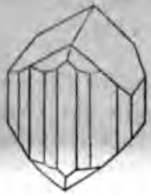


Acute Oblique Rhombi
Prism of Realgar.

Arabians, Paracelsus,
employed for medicinal

2. Arsenici Tersul
Yellow Sulphuret of Ar
Acid; King's Yellow.-
orpiment is the *auripi*
allusion both to its use
From this term the co
Nati
ante,
tion
than
cent
arse
ting
acid
and
blac
pow
cont
Dr.
limc
pyrotechnists, and as a
the present time it is n

Fig. 131.



Right Rhombic
Prism of Orpiment.

106. Ars

Arsenici Iodidum;
Arsenic.—This compou
sand-bath, a mixture
the iodide is afterwar
pound thus obtained i
iodide of arsenic or a
AsO^3+HI. If the s
but if we concentrate,
which Plisson[4] regar

---

[1] See the account of t
p. 519; and vol. xvi. p.
[2] *Ibid.* vol. xviii. p. 8
[3] *Hist. abrégée des Dr*
[4] *Journ. de Pharmaci*

Hottot,[1] is a compound of arsenious acid and teriodide of arsenic (*arsenite of teriodide of arsenic*).

Göpel[2] gives the following process for this preparation. Two drachms of iodine and one drachm of finely powdered arsenic fused at as low temperature as possible. When cool, four ounces of alcohol are to be added; the solution poured off from the residual arsenic; its colour reduced to a yellow wine colour by a current of arseniuretted hydrogen, and then evaporated in a temperature not exceeding 122° F. until it crystallises.

Dr. Meurer[3] prepares the iodide of arsenic as follows:—Arseniuretted hydrogen gas, prepared from arseniuretted zinc, is to be passed into a solution of one drachm of iodine in four ounces of spirit of wine. The gas is allowed to pass through the solution of iodine (in a place where the operator can be secure from the effects of the gas, as the outside of a window), until the solution is decolorised. A fresh quantity of iodine is then added, and the operation continued. If afterwards the clear solution becomes turbid, a small addition of iodine will render it clear again. The solution is then to be evaporated, when the iodide of arsenic (AsI^3) separates in crystals, which appear under the microscope as six sided tables.

PROPERTIES.—Iodide of arsenic combines the effects of arsenious acid and iodine. It is a powerful preparation, and, like arsenious acid, requires caution in its use. It becomes absorbed, and is eliminated by the urine, saliva, and perspiration.[4] Dr. Blake[5] injected solutions of it into the veins, but did not find its effects so powerful as might have been expected. Six grains thrown into the veins of a dog had no appreciable effect: fifteen grains immediately arrested the action of the heart. It has been employed in obstinate skin diseases, as well as in real or simulated cancer. Dr. A. T. Thomson administered it internally with great success in lepra and impetigo [and Dr. Neligan has used it internally in cases of favus]. Biett[6] employed it externally in the form of ointment, in tuberculous and herpetic diseases of the skin. In a case of lupus, the ointment has been employed with good effect. Dr. Thomson employed it in the form of pills, commencing with $\frac{1}{16}$th of a grain, and ending with $\frac{1}{3}$rd of a grain.—Biett's ointment consisted of about $2\frac{1}{2}$ grs. of the iodide to ℥j. of lard. About one drachm of this ointment may be used at once.

"An extemporaneous preparation, which is said to combine the virtues of both arsenic and iodine, is said to have been employed successfully in Philadelphia. It is formed as follows:—℞ Liquor. Iodin. comp. ℥j.; Liquor. Potassæ Arsenitis, ʒiv.: M. When mixed together in these proportions, a change is observed in the appearance of the mixture, which is instantaneously rendered almost colourless. The dose is five drops."[7]

Arsenici Superiodidum.—Wackenroder's solution of *superiodide of arsenic* is an aqueous solution of superiodide of arsenic, each drachm of which contains $\frac{1}{24}$th of a grain of metallic arsenic and about $\frac{1}{12}$th of a grain of iodine, or about the $\frac{1}{8}$th of a grain of superiodide of arsenic. Häser gave it in doses of 20 drops twice a day in scirrhus.[8]

Donovan's solution contains teriodide of arsenic and biniodide of mercury. It will be described hereafter (see *Hydrargyri Biniodidum*).

ORDER XXI. ANTIMONY AND ITS COMPOUNDS.

107. Antimonium.—Antimony.

Symbol Sb. *Equivalent Weight* 129.

Stibium.—This substance, although the basis of several important medicinal preparations, is not now used in medicine in the metallic state. In former times, *everlasting* or *perpetual*

---

[1] *Journ. de Pharmacie*, t. xiv. p. 46, 1828.
[2] *Pharmaceutical Journal*, 1850–51, p. 560.
[3] *Ibid.* 1848, p. 499.
[4] *Lond. Med. Gaz.* Jan. 19, 1839; *Lancet* for 1838-9, vol. i.
[5] *Edinb. Med. and Surg. Journal*, April 1839.
[6] Magendie, *Formulaire*, p. 244, 8me édit. 1835.
[7] *New Remedies*, by R. Dunglison, M.D. 4th edit. p. 77, Philadelphia, 1843.
[8] Dierbach, *Die neuesten Entdeckungen in der Materia Medica*, Bd. iii. Abt. ii. S. 1043, 1847.

pills (*pilulæ æternæ* se
made with it. The for
quality to wine which
antimony from the sulp
presents a stellated cr
the metal is alloyed wi
jovialis, saturninus.[1]

108. ANTI

History.—Basil
called *flowers of a*
be procured by vari
The compound is
Ph. Ed.), *protoxid*
Natural Histo
white antimony.
Preparation.—
1. The *Edinbur*

"Take of Sulphuret
Water, Ov. Dissolve
half an hour; filter.
filter; wash it well wi
again with cold water,
powder over the vapou

By the action of
obtained the terchl
chloric acid, and h
$SbCl^3+3HS$.
When the soluti
precipitate of *oxic*
becomes crystalline
This precipitate is
name of an Italian
It has also been ter
of life (*mercurius*
oxichloride loses all
teroxide of antimo
Washing it with a
oxide. $SbCl^3,5Sb$
2. The *Dublin*
(*Antimonii oxydu*

Take of Solution

---

[1] [The crude antimony
Vienna and Trieste in t
being lighter in weight
a closer appearance and
[2] *Triumphant Chariot*

Caustic Potash, Oj.; Distilled Water, a sufficient quantity. Pour the antimonial solution into the water, and having stirred the mixture well, set it by until the white precipitate which forms has subsided. Draw off the supernatant liquor by decantation, or the syphon, and, having agitated the sediment with a gallon of distilled water, allow the whole to stand till the oxide has fallen to the bottom. Decant again, and having placed the whole on a calico filter, wash it with distilled water, until the liquid which trickles through reddens blue litmus paper only in a very slight degree. The precipitate is now to be shaken occasionally for half an hour with the solution of caustic potash, and then washed on a filter with boiling distilled water until the washings cease to give a precipitate on being dropped into an acid solution of nitrate of silver. Lastly, let the product be dried at a heat not exceeding 120°.

3. Another method of obtaining teroxide of antimony is by the action of sulphuric acid on either metallic antimony or the black sulphuret of antimony. By boiling powdered metallic antimony in sulphuric acid, sulphurous acid escapes, and the tersulphate of the oxide of antimony is obtained. $Sb+6SO^3=SbO^3,3SO^3+3SO^2$. By the action of water, this tersulphate of antimony is resolved into an insoluble subsulphate, SbO^3,SO^3, and a soluble supersulphate, of antimony. By the action of carbonate of soda, the subsulphate is converted into the teroxide of antimony. $SbO^3,SO^3+NaO,CO^2=SbO^3+NaO,SO^3+CO^2$. This method of procuring teroxide of antimony was proposed by Mr. R. Phillips[1] in 1811. The late Dr. Babington[2] suggested the substitution of the black sulphuret of antimony for metallic antimony. For some years past, teroxide of antimony, for the preparation of emetic tartar, has been obtained by some English chemical manufacturers by the action of sulphuric acid on sulphuret of antimony. This process has been publicly recommended by M. Hornung[3] as the most economical one for the preparation of antimony for the manufacture of emetic tartar. As it is probable that it will be generally adopted, I subjoin Hornung's account of it.

Fifteen parts of sulphuret of antimony, in fine powder, were mixed with thirty-six parts of sulphuric acid in an iron vessel, and the mixture exposed to a gentle heat during a night. The mixture had become thick; but, on elevating the temperature and stirring it, it again assumed a liquid condition. After continuing the action for some time, the mass acquired a whitish appearance, a portion of sulphur separated in the fused state, and much sulphurous acid was disengaged. The heat and agitation were continued until in this way the whole of the sulphur was burned out, and sulphurous acid no longer disengaged. When the only vapours evolved were those of sulphuric acid, water was added to wash out the free sulphuric acid; and the residue of subsulphate of antimony was decomposed with carbonate of soda, leaving oxide of antimony in the form of a greenish white powder.

Fifteen parts of sulphuret yielded thirteen parts of dry oxide, which, with the exception of a small quantity of impurity, dissolved in solution of tartaric acid.

In commenting on this process, Mr. Phillips[4] observes that "there is no use in gently heating the mixture for a long time: it may be boiled to dryness at once; and the residue is fit for preparing tartarised antimony when merely washed with water, and without using any carbonate of soda."

By the mutual reaction of sulphuret of antimony and sulphuric acid, we obtain tersulphate of oxide of antimony, sulphurous acid, and sulphur. $SbS^3+6SO^3=SbO^3,3SO^3+3SO^2+3S$. By the heat employed, the sulphur and sulphurous acid are dissipated. By washing, the excess of sulphuric acid

---

[1] *Experimental Examination of the London Pharmacopœia.*

[2] See *Philosophical Magazine* for July 1848.

[3] *Journal de Pharmacie*, Mai 1848; *Pharmaceutical Journal*, October 1848.

[4] *Phil. Mag.* July 1848.

is removed, and the t
subsulphate, SbO^3,S
is afterwards conve
SbO^3,SO^3+NaO,CO
subsulphate may be

Sulphuretted Terox
of Antimony, are someti
which they contain; he
1. Antimony Ash;
dered black sulphuret o
emetic tartar as a cheap
formed on the large sca
set over a fire: the fum
most part burnt off an
oxygen from the air.
antimonious acid (SbO^4)
sulphuret of antimony (S
sulphuret which have n
is volatilised during the
2. Glass of Antim
sulphuret of antimony
This is then fused in an
deprived of a part of its
sulphurous acid, which
consists of *teroxide of a*
iron 3·2. Mr. R. Philli
tersulphuret, and about
antimony in the prepar
3. Saffron of Ant
deflagrating a mixture
the resulting fused ma
separated from the sc
washed: it then constit
formerly used in the
sulphate of potash, tero
and tersulphuret of anti
the sulphate of potash,
Liver of antimony is
carbonate of either pota
phuret of antimony and
and potash.
Ruby of antimony (
fusing together five par
potash, and separating
one, which consists of a
the teroxide.

Properties.—Te
crystals, which belor
moist way it is a wh
full red heat into a
mass. If subjected
antimonious acid (Sb

Characteristics.—
solved: the solutio

---

[1] Liebig. *Handwört.*
[2] *Journal de Pharma*
[3] *Translation of the*

with water, yields a white precipitate (*oxichloride of antimony*, $SbCl^3,5SbO^3$). Hydrosulphurets form a red precipitate (SbS^3) in the solution of the terchloride. Boiled with tartaric acid, or with a solution of bitartrate of potash, it is dissolved: the latter solution yields, on cooling, crystals of emetic tartar ($KO,SbO^3,\bar{T},2HO$), the characteristics of which will be hereafter given. Teroxide of antimony melts before the blow-pipe, and is volatilised in the form of a white vapour.

COMPOSITION.—Teroxide of antimony has the following composition:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Berzelius.*	*John Davy.*
Antimony	1	129	84·31	84·319	85
Oxygen	3	24	15·69	15·681	15
Teroxide of Antimony	1	153	100·00	100·000	100

PURITY.—The Edinburgh College gives the following characteristics of its purity:—

"Entirely soluble in muriatic acid, and also in a boiling mixture of water and bitartrate of potash; snow-white; fusible at a full-red heat."

PHYSIOLOGICAL EFFECTS AND USES.—Teroxide of antimony possesses similar medicinal properties to emetic tartar, in the preparation of which it is used. It is rarely employed as a medicine. [As obtained by precipitation, it has been used by M. Tessier,[1] of Lyons, in the treatment of pneumonia, upon which disease, in the opinion of that physician, it has a specially resolvent power, more particularly marked towards the fourteenth or fifteenth day of the attack. The observations of M. Tessier have been confirmed by other physicians at Lyons.—ED.] The oxichloride of antimony is uncertain in its operation.

ADMINISTRATION.—The oxichloride of antimony is sometimes given in doses of from one to ten grains.

109. PULVIS ANTIMONII COMPOSITUS.—COMPOUND POWDER OF ANTIMONY.

HISTORY.—Dr. James, who died in 1776, prepared a celebrated patent medicine, long known as the *fever powder of Dr. James* (*pulvis febrifugus Jacobi*), or *Dr. James's powder* (*pulvis Jacobi*). The discovery of it was subsequently claimed for a German of the name of Schwanberg.[2] The specification which Dr. James lodged in the Court of Chancery is so ambiguously worded, that his powder cannot be prepared by it. Hence the present preparation has been introduced into the Pharmacopœia as a substitute for it. In former editions of the London Pharmacopœia, as well as in the present Edinburgh and Dublin Pharmacopœias, the name given to it is *pulvis antimonialis* (*antimonial powder*); but since 1836 this name has been unnecessarily (as I conceive) altered to *pulvis antimonii compositus*.

PREPARATION.—All the British Colleges give directions for its preparation.

The *London College* orders, of Tersulphuret of Antimony, lb. j.; Horn Shavings, lb. ij. Mix, and throw them into a crucible red-hot in the fire, and stir constantly until vapour

---

[1] *Bulletin Thérap. Méd.* t. xxxv. p. 237.

[2] *Affidavits and Proceedings of W. Baker*, Lond. 1754.

no longer arises. Rub
fire, and increase it gra
powder as finely as poss
The *Edinburgh Colle*
powder, and Hartshorn
iron pot, and stir const
arise. Pulverise the p
expose this to a gradual
maintained for two hou

Manufacturers us

The process of the *D*
of Tartarised Antimony
Solution of Ammonia, f
the Tartarised Antimon
cium, each, in a quart o
phosphate of soda when
first added to the latter t
collected the precipitate,
water until the liquid w
solution of nitrate of s
reduce it to a fine powd

The following is th
horn (or bones) is d
matter (triphosphate
CaO,CO^2). The sulp
of sulphurous acid (3
forming antimonious
mony (SbO^3). By th
converted into antimo
while another is volat
by the united agencie
and a small quantity
in which the second s
the end of the operati
yellow crystals of tero
PROPERTIES.—Anti
Boiling water extracts
phosphate) of lime :
acid, digested in the r
oxide of antimony, an
combination with lin
powder appears to be
Characteristics.—
distilled water occasio
of ammonia, nitrate o
first of these tests is o
of silver ($2AgO,bPO^5$)
Hydrosulphuric acid
orange-red precipitate.
by distilled water be d
obtained, which, on
deposits a white powd

I have found this to take place with several samples of antimonial powder which I have examined, and the same is noticed by Dr. Barker;[1] but neither Mr. Phillips[2] nor Dr. Maclagan[3] has observed it. Hydrosulphuric acid gas, transmitted through the hydrochloric solution, causes an orange-red precipitate: if this be separated by filtering, and the solution boiled to expel any traces of hydrosulphuric acid, a white precipitate (*triphosphate of lime*, $3CaO,cPO^5$) is thrown down on the addition of caustic ammonia. That portion of antimonial powder which is not dissolved by hydrochloric acid is antimonious acid: if it be mixed with soda, and heated on charcoal in the interior flame of the blowpipe, it is converted into globules of metallic antimony.

"Distilled water, boiled with it and filtered, gives, with sulphuretted hydrogen, an orange precipitate: muriatic acid digested with the residue, becomes yellow, does not [*sometimes does, according to my experiments*] become turbid by dilution, but gives a copious orange precipitate with sulphuretted hydrogen."—*Ph. Ed.* 2d edit. 1841.

COMPOSITION.—*Dr. James's powder* has been analysed by Dr. Pearson,[4] by Mr. Phillips,[5] by Berzelius,[6] by M. Pully,[7] by Dr. D. Maclagan,[8] and was imperfectly examined by M. Chenevix.[9] *Antimonial powder* has been analysed by Mr. Phillips,[10] and by Dr. D. Maclagan.[11] Their results are, for the most part, shown in the following table:—

	JAMES'S POWDER.					ANTIMONIAL POWDER.		
	Pearson	Phillips.	Berzel.	Maclagan.		Phillips.		Maclagan.
		Newbury's		Newbury's	Butler's	1st samp.	2d samp.	
Antimonite of Lime [with some superphosphate, *Maclagan*]	—	—	1	3·40	2·25	—	—	0·8
Teroxide of Antimony ...	—	—	—	2·89	9·80	—	—	3·98
Antimonious Acid	57	56·0	66	43·47	34·21	35	38	50·09
Triphosphate of Lime ...	43	42·2	33	50·24	53·21	65	62	45·13
Loss [Teroxide of Antimony and impurity, *Phillips*]	—	1·8	—	—	0·53	—	—	—
	100	100·0	100	100·00	100·0	100	100	100·00

According to the Edinburgh Pharmacopœia (2d ed. 1841), antimonial powder is "a mixture chiefly of *antimonious acid* and *phosphate of lime* with some *sesquioxide* [teroxide] *of antimony* and a little *antimonite of lime*."

Pully found *sulphate of potash* and *hypo-antimonite of potash* in James's powder.

---

[1] *Observations on the Dublin Pharmacopœia*, 204.
[2] *Ann. Phil.* iv. N. S. 266.
[3] *Edinburgh Medical and Surgical Journal*, No. 135.
[4] *Phil. Trans.* lxxxi. for 1791, p. 317.
[5] *Ann. Phil.* N. S. vi. 187.
[6] *Traité de Chimie*, iv. 481.
[7] *Ann. de Chim.* 1805, lv. 74.
[8] *Op. supra cit.*
[9] *Phil. Trans.* for 1801, p. 57.
[10] *Ann. Phil.* N. S. iv. 266.
[11] *Op. cit.*

Mr. Brande has found a
powder of the shops.
powder in distilled wate
existence of *superphosp*
with the salts of lead an
if any, *teroxide of antim*
pitate on the addition
excess of this acid wit
water. Dr. Maclagan[1]
the solution, an orange-
of the presence of ter
water, to remove compl
the least trace of this
obtained, which not onl
even causes a white pre

PHYSIOLOGICAL
ration,—at one time
or nearly so. This
antimony, which m
which, when present
over, this variation i
as the fault of the m
observed, " upon sli
controlled." Mr. H
effect; and the late
times a day, without
even 120 grains nea
duced. In these ins
But, on the ather
it to possess activity.
chemist to persuade
from the exhibition
experiments on whic
contains but little if
I am acquainted wit
workman employed i
operative chemist in
I estimate at half a t
him." It occasione
Dr. James's pow
certain than our ant
operation. Dr. D.
James himself, as w
other active preparat
even when given in
little visible effects.

---

[1] *Op. cit.*
[2] *Manual*
[3] *Edinburg*
[4] *Cases ill*
[5] *Pharmac*
[6] *Treatise*

and downwards; and I was once called to a patient to whom Dr. James had himself given five grains of it, and it purged and vomited the lady for twenty-four hours, and in that time gave her between twenty and thirty stools; at other times I have seen a scruple produce little or no visible effect." Dr. Cheyne[1] thought highly of it in the apoplectic diathesis: but he used it in conjunction with bleeding, purgatives, and a strict antiphlogistic regimen. The preceding facts seem to me to show the propriety of omitting the use of both antimonial and James's powder, and substituting for them some antimonial of known and uniform activity,—as emetic tartar.

USES.—Antimonial powder is employed as a sudorific in fevers and rheumatic affections. In the former it is given either alone or in combination with mercurials: in the latter, it is frequently conjoined with opium as well as with calomel. In chronic skin diseases it is sometimes exhibited with alteratives.

ADMINISTRATION.—The usual dose of it is from 3 or 4 to 8 or 10 grains, in the form of powder or bolus.

110. ANTIMONII TERSULPHURETUM.—TERSULPHURET OF ANTIMONY.

Formula SbS^3. *Equivalent Weight* 177.

Two forms of this compound are used in medicine—the one crystalline, the other amorphous.

1. Antimonii Tersulphuretum Crystallisatum.—Crystallised Tersulphuret of Antimony.

HISTORY.—Black sulphuret of antimony was known in the most ancient times, being used by the Asiatic and Greek ladies as a pigment for the eyebrows.[2] It was formerly called *stimmi* (στίμμι vel στίμμις), *stibium* (στίβι), *platyophthalmon* (πλατυόφθαλμον), or *larbason*[3] (λάρβασον). It has also been called κόχλος. In the native state it is technically termed *antimony ore*, and when first fused out of its gangue, *crude antimony*, or *sulphuret of antimony*. It is the *antimonii sulphuretum* of the Edinburgh and Dublin Pharmacopœias; the *antimonii tersulphuretum* (*tersulphuret of antimony*) of the London Pharmacopœia.

NATURAL HISTORY.—Tersulphuret of antimony is found native in various parts of the world, especially in Hungary, in the Hartz, in France, in Cornwall, and in Borneo. From the latter place it is imported into this country by way of Singapore, being brought over as ballast in the vessels. In the years 1835-36 and 37, the quantities of ore imported were respectively 645, 825, and 629 tons (*Trade List*, Jan. 10, 1837, and Jan. 9, 1838). In 1840, there were imported 627 tons.

PREPARATION.—The old method of separating the tersulphuret from its silicious gangue was to melt it in a covered crucible or pot, in the bottom of

---

[1] *Dubl. Hosp. Rep.* i. 315.

[2] 2 *Kings*, ix. 30; *Ezekiel*, xxiii. 40; Pliny, *Nat. Hist.* xxxiii.

[3] Dioscorides, lib. v. cap. 99.

which there were se
an inferior or receivi
pots were placed in
curved earthen tube
furnace. At La Ve
on the bed of a rev
passage of the fused
externally to the fur

PROPERTIES.—Th
occurs in commerce
broken, present a s
colour, and a metal
tasteless, odourless,
Its powder is black,
little less fusible than
and it appears to be
earthen crucible for
By roasting, it is co
fine powder by levig
retum præparatum

Characteristics.–
smell of sulphurous a
in warm hydrochlori
of terchloride of anti
chloride of antimo
(SbS^3) with hydrosul
over heated tersulph
acid gas are obtained
powder: it readily d

COMPOSITION.—T

Antimony.............
Sulphur ....

Tersulphuret of Ant

IMPURITIES.—The
It frequently contain
this account it is not
soluble in hydrochlor
this remains undissol
of charcoal and carbo
with water (so as to
of lead, iron, or copp
priate tests for these

Striated. Soluble in
" Entirely soluble in m

1

PHYSIOLOGICAL EFFECTS. *α. On Animals.*—Rayer[1] introduced half an ounce of it into the cellular tissue of the back of a dog, but no effects resulted from it. Fifteen grains placed in the peritoneal sac caused inflammation, and in twenty-four hours death, but without any peculiar symptoms. Moiroud[2] says that, given to horses in doses of from two to four ounces, it acts as an excitant, causing increased frequency of pulse and respiration, and softer stools.

β. On Man.—In most cases it produces no obvious effects, even when taken in very large doses. Rayer[3] gave half an ounce of it in powder for several days without the slightest effect. Cullen,[4] however, has seen it cause nausea and vomiting in one or two instances in which it was largely employed. Rayer says that the decoction of it is much more active than an equal quantity of the same preparation in powder. How are these facts to be explained? He ascribes the activity of the decoction to arsenious acid, formed by boiling sulphuret of arsenic (contained in the ordinary crude antimony) with water; for Guibourt[5] obtained in this way $1\frac{45}{100}$ grs. of arsenic acid by boiling an ounce of crude antimony. But the presence of arsenic is not necessary to explain the greater activity of the decoction, since, by long-continued boiling with water, the tersulphuret of antimony yields hydrosulphuric acid and teroxide of antimony.[6] The occasional nausea and vomiting may arise from the decomposition of the sulphuret by the fluids in the alimentary canal.

USES.—As a medicinal agent, it is occasionally employed as a diaphoretic and alterative in some skin diseases, especially lepra and scabies, in scrofula and glandular affections, and in rheumatism and gout.

As a pharmaceutical and chemical agent, it is a most important substance, being the source from which the metal and all its compounds are procured.

ADMINISTRATION.—The usual dose of it, when taken internally, is from ten to thirty grains of the powder; but several drachms of it have been taken without much effect. The *Tisan de Feltz*, which is occasionally used in skin diseases, is prepared by boiling Sarsaparilla, ℥j. and Crude Antimony (tied up in a bag), ℥j. in a pint and a half of Water; then add Isinglass, ʒiv., previously dissolved in water, and reduce the whole (by boiling) to a pint, which is to be taken during the day.[7]

ANTIMONII SULPHURETUM PRÆPARATUM, D.; *Prepared Sulphuret of Antimony.* (Take of Sulphuret of Antimony any convenient quantity. Let this be reduced to powder; and the finer particles having been separated from the coarser by the method explained in the formula for *Creta Præparata*, let them be dried and preserved for use.)—The powder sold in the shops as prepared sulphuret is usually obtained by grinding in mills without elutriation. Its uses are those of the sulphuret before described.

---

[1] *Dict. de Méd. et Chir. Pratiq.* iii. 54.

[2] *Pharm. Vétér.* 428.

[3] *Op. cit.*

[4] *Treat. of Mat. Med.* ii. 482.

[5] Rayer, *op. supra cit.*

[6] Geiger, *Hand. d. Pharm.*

[7] Rayer, *Treatise on Diseases of the Skin*, by Dr. Willis, p. 1223.

2. Antimonii

History.—Red t
who calls it *sulphui*
follows:—Grind an
hours, or a little lo
boiled liquor, and po
be precipitated.
The discovery of
colour to the insect k
Glauber, one of whc
de Chastenay, by wh
gave a portion of th
remarkable cure wi
powder, poudre d
secret of its prepar
of France.[2]
Natural Histor
native. The minera
Varieties.—Two
ployed in medicine;
the precipitated sulp

a.

Preparation.—T
way; and the Fren
methods.
a. By the humid

Take of Crystallised
Antimony, 6 parts. Di
cast-iron pan. Add the
mixture for an hour, co
tion into an earthen pan
water. Let the solutic
deposited on a close clot
powder, and dry it on a

The *theory* of this p
boiled with a solutio
into carbonic acid an
and produces sulphur
$3NaS + SbO^3$. The

---

[1] *Basil Valentine, his T*
ringius, M.D. p. 131, Lond
[2] Lemery, *Sur une Prép*
Kermes Mineral, in the *Mé*

antimony, the quantity of which is greater in proportion as the liquid is hotter and more concentrated. $3NaS + xSbS^3$. The teroxide of antimony combines with soda, $NaO + SbO^3$. As the solution cools, amorphous red tersulphuret of antimony is deposited. This is *kermes minerale*. If the quantity of soda employed be insufficient to hold the whole of the teroxide in solution, a portion of this is also deposited, as the liquid cools, in the form of acuminated six-sided prisms or needles, which, by the microscope, are seen to be mechanically mixed with the red tersulphuret (H. Rose).

The relative proportions of sulphuret of antimony and alkaline carbonate directed to be employed by different authorities are remarkably different. Whatever process be followed, it is essentially requisite, in order to obtain good-coloured kermes of a fine and velvety quality, that the solution be cooled as slowly as possible. This, in fact, is the principal secret in its manufacture. Both Berzelius[1] and Rose[2] state that mineral kermes contains some alkaline sulphuret. According to Rose, it is in combination with pentasulphuret of antimony, the formation of which depends on the absorption of atmospheric oxygen by the solution. $2O + 3(NaS,SbS^3) = 2NaO + NaS,SbS^5 + 2SbS^3$.

β. By the dry way.—The process of the French Codex for ***kermes igne paratum*** is as follows:—

> Take of Sulphuret of Antimony, 500 parts; Carbonate of Potash, 1000 parts; and Sulphur, sublimed and washed, 30 parts. Carefully mix these three substances, and fuse in a Hessian crucible. Pour the mass, while liquid, into an iron mortar, and, when cold, reduce it to powder. Then boil the powder in an iron pan, with 10000 parts of water, filter the boiling liquor, allow it to cool slowly, then decant it, and collect the kermes on a filter; wash it and dry it as already mentioned.
>
> The quantity of kermes obtained by this process is greater, but less fine, than that procured by the preceding process; and it ought to be exclusively reserved for veterinary medicine.

This is Baumé's method of preparing kermes. According to Berzelius, the best proportions of the ingredients are 1 part of pure carbonate of potash, and 2¼ parts of tersulphuret of antimony. The changes effected by the fusion are analogous to those before explained. $4(KO,CO^2) + 4SbS^3 = KO, SbO^3 + 3(KS, SbS^3) + 4CO^2$. The *Codex* obviously directs an excess of carbonate of potash to be used. The addition of sulphur augments the quantity, but injures the colour, of the kermes, probably because it promotes the formation of pentasulphuret of antimony, SbS^5.

PROPERTIES.—Mineral kermes is an odourless, tasteless, brownish-red powder, insoluble both in water and in alcohol. Examined by the microscope, it is seen to consist of a reddish or brownish granular mass, which, when the kermes contains teroxide of antimony, is intermixed with acuminated prisms or small acicular crystals of this substance. Dilute mineral or vegetable acids abstract any contained teroxide: concentrated hydrochloric acid decomposes the tersulphuret. $SbS^3 + 3HCl = SbCl^3 + 3HS$. Mineral kermes is completely soluble in hydrosulphuret of ammonia.

COMPOSITION.—The following is the composition of mineral kermes according to H. Rose:—

---

[1] Schweigger's *Journal*, Bd. xxxiv. S. 58; also, Poggendorff's *Annalen*, Bd. xx. s. xxxvii.

[2] Poggendorff's *Annalen*, Band xlvii. S. 323 (also, *Berl. Jahrb. für die Pharmacie*, Band xlii. 1839).

Kermes prepared by boili Carbonate of Soda ; b very carefully dried	
Antimony.........	(
Sulphur	;
Sodium............	
Water	
	1(

According to Ros
with the sulphantim
that prepared by boi
a short time only, co
be washed for a long
Berzelius and Fu
kermes is an amorp
have analysed this s
considers this an acc
quantity of alkali to
hand, regards it as
kermes $2SbS^3+SbO$
thus stated:—

Tersulphuret of
Teroxide of Anti

PHYSIOLOGICAL E
sulphuret of antimo
Pharmacopœia, are a
degree. They are m
they may contain is g
is entirely devoid of
become soluble in t
Kermes mineral is
The effects of kermes
and which will be m
Tartras). In smal
emetic and purgative
USES.—In Engla
parts of Europe, esp
tic tartar, it has bee
or hyposthenic in in
tainty of its operation

---

[1] *Handwört. d.*
[2] See Dr. Stack's

it possesses activity, it is doubtful whether it has any advantages over emetic tartar. Some writers, however, assert that it is less irritating to the stomach and bowels: but assuming this to be true, it is probably referable to its inferior activity.

ADMINISTRATION.—Mineral kermes is given, in the form of powder or pill, in doses of from half a grain to two or three grains.

b. *Antimonii Tersulphuretum Præcipitatum.—Precipitated Tersulphuret of Antimony.*

All the British Colleges give directions for the preparation of an amorphous antimonial sulphuret, called by the London College *antimonii oxysulphuretum;* by the Edinburgh College, *antimonii sulphuretum aureum;* and by the Dublin College, *antimonii sulphuretum precipitatum.*

The *London College* orders of Tersulphuret of Antimony, ℥vij.; Solution of Soda, Oiv.; Distilled Water, *Cong.* ij.; Diluted Sulphuric Acid, as much as may be sufficient. Mix the sesquisulphuret of antimony, solution of potash, and water together, and boil with a slow fire for two hours, frequently stirring, distilled water being often added, that it may fill about the same measure. Strain the liquor, and gradually pour into it as much diluted sulphuric acid as may be sufficient to precipitate the oxysulphuret of antimony; then, with water, wash away the sulphate of soda, and dry what remains with a gentle heat.

The *Edinburgh College* orders of Sulphuret of Antimony, in fine powder, ℥j.; Solution of Potash, f℥xvj.; Water, Oij.

The *Dublin College* gives the following directions:—Take of Prepared Sulphuret of Antimony, ℥v.; Carbonate of Potash from Pearlash, first dried by a low red heat, and reduced to powder, ℥iv.; Water, *Cong.* j.; Pure Sulphuric Acid, f℥ij.; Distilled Water, Oij. Mix the sulphuret of antimony and Carbonate of Potash in a mortar, and heat the mixture in a Hessian crucible, first cautiously until effervescences ceases, and then to low redness, so as to produce liquefaction. Pour out the melted mass on a clean flag, and, when it has concreted and cooled, rub it to a fine powder in a porcelain mortar. Add this, in successive portions, to the gallon of water while boiling in an iron vessel, and, having maintained the ebullition for twenty minutes, transfer the whole to a calico filter, and cause the solution which passes through to drop into the distilled water previously mixed with the sulphuric acid. Let the precipitate which forms be collected on a calico filter, and let warm distilled water be repeatedly poured upon it, until the liquid which passes through ceases to give a precipitate when dropped into a solution of nitrate of barytes. Finally, dry the product on porous bricks placed in a warm atmosphere.

The *theory* of the process has been already in part explained. When the common black tersulphuret of antimony is boiled with a solution of caustic potash, sulphuret of potassium and teroxide of antimony are produced, $3KO + SbS^3 = 3KS + SbO^3$: the former combines with and dissolves some tersulphuret of antimony ($3KS + xSbS^3$), while the latter unites with potash ($KO + SbO^3$). Thus the solution contains hyposulphantimonite of potassium and hypantimonite of potash. When sulphuric acid is added to the strained liquor, it decomposes the sulphuret of potassium, precipitates the tersulphuret of antimony, and combines with the potash which retained the teroxide of antimony in solution: the latter is wholly, or in great part, re-converted into tersulphuret of antimony. $4SO^3 + 3(KS,SbS^3) + KO,SbO^3 = 4(KO,SO^3) + 4SbS^3$. From Mr. Phillips's analysis, it would appear that some teroxide of antimony escapes decomposition, and is contained in the precipitated product. It is probable that the precipitate sometimes contains pentasulphuret of antimony, SbS^5. This is formed by the action of atmospheric oxygen on the al-

kaline solution prior
$2KO+KS,SbS^5+$

PROPERTIES.—O
less powder. It is
ammoniæ. Boiled
in solution, and so
burns, evolves sulp

Characteristics.
evolves hydrosulphu
sulphurets or oxysu
colour. Its hydro
for this metal. W
of emetic tartar is
after to be mention

COMPOSITION.—
according to Mr.
presumed to contai
follows:—

Teroxide Anti
Tersulphuret
Water ....

Oxysulphuret

By microscopic
antimony in sampl
myself.

From the mode
mixture of amorpho
SbS^5. In other w
the alkaline sulphu
College, it is "a
sesquioxide of antin

PURITY.—Recen
completely soluble i
a white residuum.
tion of hydrosulph
but becomes quite
acid. It should n

The *London Co*

Of a golden-red colo
solved by hot hydroc
remaining. These sol

The *Edinburgh*

"Tasteless: twelve
of it, forming a colour

The commercial

---

[1] This method of deter
on (see H. Rose, Poggen

according to the process of the Pharmacopœia. A manufacturer of it informs me that it is prepared by boiling sulphur with the black sulphuret of antimony and potash, and precipitating by an acid in the usual way. Mr. Redwood[1] mentions two ways by which a product resembling the usual commercial article may be procured: one is, by boiling together 4 parts of black sulphuret of antimony, 8 parts of lime, and 80 parts of water, and precipitating the strained solution by excess of hydrochloric acid; the other is by fusing together 2 parts of black sulphuret of antimony, 4 parts of carbonate of potash, and 1 part of sulphur, boiling the fused mass when cold in 20 times its weight of water, and precipitating by a large excess of dilute sulphuric acid.

PHYSIOLOGICAL EFFECTS.—The medicinal activity of this preparation is greater in proportion to the quantity of teroxide of antimony which it may contain. The obvious effects are precisely analogous to those of emetic tartar; namely, vomiting, purging, and sweating. In small doses, it is employed as an alterative, expectorant, and diaphoretic; in somewhat larger doses, it causes nausea and sweating, and sometimes vomiting; in still larger quantities, it excites both vomiting and purging.[2]

USE.—It is principally employed as an *alterative* in chronic diseases, particularly cutaneous affections, glandular enlargements, secondary syphilis, rheumatism, and diseases of the liver. In these complaints it is usually associated with mercurials (especially calomel), and sometimes with either guaiacum or narcotics.

ADMINISTRATION.—As an alterative, the dose is from one to three or four grains; as an emetic, from five grains to a scruple. It is a constituent of the *pilulæ hydrargyri chloridi compositæ*, commonly termed *Plummer's pill*.

ANTIDOTES.—Vide *Antimonii et Potassæ Tartras*.

111. Antimonii Pentasulphuretum.—Pentasulphuret of Antimony.

Formula SbS^5. *Equivalent Weight* 209.

Sulphur Antimonii Auratum; Golden Sulphuret of Antimony; Stibium Sulphuratum Aurantiacum.—Obtained by adding a diluted mineral acid (usually sulphuric acid) to the mother liquor from which mineral kermes has been deposited: the precipitate is to be washed and dried. Its formation has been before explained (see *ante*, p. 734). *Schlippe's salt* is the sulphantimoniate of sodium, $3NaS,SbS^5,18HO$. When it is decomposed by sulphuric acid, the golden sulphuret of antimony is precipitated. $3NaS,SbS^5,18HO+3SO^3=3(NaO,SO^3)+SbS^5+3HS+15HO$. Golden sulphuret of antimony is an orange-red, odourless, and tasteless powder. In its medicinal properties and uses it resembles mineral kermes and precipitated sulphuret of antimony. The dose is from half a grain to two or three grains.

---

[1] Gray's *Supplement to the Pharmacopœia*, 2d edit. 1848.

[2] For some experiments and observations on the action of *Kermes Mineral* and the *Golden Sulphuret*, consult Rayer, in *Dict. de Méd. et Chir. Prat.* iii. 57, *et seq.*

112. ANTIMO

F

History.—Basil
has had various appe
butyrum antimonii),
of antimony, protoc

Preparation.—T
mony, which, in the
the shops and used i
impure solution of t
containing a large q
Pharm. Bor., 1846.
ash in hydrochloric a
mon crude antimony
nitric acid facilitates t
to be prepared by d
in lb. iv. of crude hyd
rated to lb. iss., and
distilled water, are to
the sp. gr. of 1·345 t

By the action of l
obtain terchloride of
$3HCl = SbCl^3 + 3HS$.
in excess of liquid hy
terchloride of antim
this solution be subm
acid are first expelled
on cooling. If, ther
be procured from the
as the distilled produ
of the commercial b
to it.

Properties.—The
varying in its colour
it is yellowish: the d
is due to pernitrate of
College fix it at from
ammonia is present),
acid. It reacts on ve

Characteristics.—
(*oxichloride of antin*
The hydrosulphurets
by sulphuret of iron
tate of the white terox
oxide of iron, Fe^2O^3.
and SbO^3).

Composition.—Ter

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Göbel.*	*H. Rose.*
Antimony	1	129	54·8	54·98	53·27
Chlorine	3	106·5	45·2	45·02	46·73
Terchloride of Antimony	1	235·5	100·0	100·00	100·00

The butter of antimony of the shops consists of *terchloride of antimony, free hydrochloric acid*, a little *nitrous acid, water*, and *sesquichloride of iron*. It may also contain other impurities derived from the tersulphuret from which it is separated. Serullas says he never found arsenic in it.

PHYSIOLOGICAL EFFECTS.—It acts as an energetic caustic; but I am not acquainted with any cases of poisoning by it. It cannot be much diluted without undergoing decomposition.

USES.—In medicine it is employed only as a caustic. It usually acts without much pain or inflammation, and, after the separation of the eschar, produces a clean healthy surface. It is sometimes used as an application to parts bitten by rabid animals or venomous serpents; its liquidity enabling it to penetrate into and corrode all parts of the wound. It is also applied to ulcers to repress excessive granulations. Richter and Beer have employed it in staphyloma: the mode of applying it is as follows:—Dip a camel's hair pencil, or a point of lint, into the liquid, and apply it to the tumour until a whitish crust is perceived, when the whole is to be immediately washed away by means of a larger pencil dipped first into milk and afterwards into milk and water.

ANTIDOTES.—The treatment of poisoning by this preparation is the same as for the mineral acids. After the use of antacids, vegetable astringents (tea and infusion of nutgalls) should be administered to neutralise the effect of the oxichloride of antimony separated in the stomach.

ANTIMONII TERCHLORIDI LIQUOR, D. (Take of Prepared Sulphuret of Antimony, lb. j.; Muriatic Acid of Commerce, Oiv.:—Upon the sulphuret, placed in a porcelain capsule, pour the acid, and, constantly stirring, apply to the mixture, beneath a flue with a good draught, a gentle heat, which must be gradually augmented as the development of the gas begins to slacken, and finally carried to ebullition, and maintained at this temperature for fifteen minutes. The vessel being now removed from the fire, let its liquid contents be separated by filtration through calico, returning what passes through first, in order that a perfectly clean solution may be obtained. Transfer the liquid to another capsule, and, having boiled it down to the bulk of one quart, allow it to cool, and preserve it in a bottle furnished with a well-ground glass stopper. The specific gravity of this solution is 1470.)

113. ANTIMONII ET POTASSÆ TARTRAS.—TARTRATE OF ANTIMONY AND POTASH.

Formula $KO,SbO^3,C^8H^4O^{10},3HO$; or $KO,SbO^3,\overline{T},3HO$. *Equivalent Weight* 359.

HISTORY.—This salt was first publicly noticed in 1631 by Hadrian de Mynsicht.[1] "But the preparation was in all probability suggested by a treatise, entitled *Methodus in pulverem*, published in Italy in 1620. This

---

[1] *Thesaurus Medico-Chymicus.*

book, written by Dr.
a powder which had
had acquired celebrit
it had performed. T
antimony, and tartar,
produced would natu
of antimonial preparat

This salt has had
(*tartarus emeticus,*
(*antimonium tartari*
potassio-tartras, L.)
tartras) ; *stibium o*
atum, &c.

PREPARATION.—T
water and cream of ta
$KO,SbO^3,\bar{T},3HO$.

Formerly, either saffr
antimonii) was employed
Antimony ash (*cinis anti*
to obtain teroxide of ant

If the teroxide of
substance and of crea
equivalent, or 153 pa
the crystals of cream

The *London Phar*
the preparation of thi

Take of Tersulphuret
f℥xv. ; Bitartrate of Po
acid in an iron vessel ; t
with an iron spatula ; th
extinguished, nothing re
cold with water until n
this salt with the bitartr
while still hot, and set a
these, and again evapora

The *Edinburgh C*
of this salt :—

Take of Sulphuret of
Water, Ov. Dissolve t
half an hour ; filter ; pou
filter, wash it with cold
cipitate over the vapour
and ʒij. ; Water, f℥xxvij
set the liquid aside to c
crystals, but not so free

In this process, ter
this is first converted
washing, is converte

---

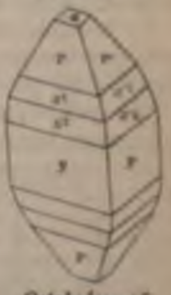
[1] Thomson'

in the subsequent part of the process, with the bitartrate, and forms emetic tartar. This is an excellent process for the manufacture of emetic tartar. [It differs from that of the London College in the substitution of hydrochloric for sulphuric acid.—ED.]

The *Dublin College* orders Emetic Tartar to be thus prepared:—Take of Oxide of Antimony, ℥v.; White Bitartrate of Potash, ℥vj.; Distilled Water, Oij. Rub the bitartrate to a fine powder, and, having carefully mixed it with the oxide of antimony, add a little water, so as to convert the matter into a thick paste, which should be set by for four-and-twenty hours. Pour on this the remainder of the water, previously raised to the temperature of 212°, and, having boiled for fifteen minutes, with repeated stirring in a glass or porcelain vessel, filter through calico, returning the slightly turbid liquor which passes through, so as to obtain a clear solution. After twelve hours let the liquid be decanted from the crystals which will have formed, and boil to one third, when, upon cooling, an additional product will be obtained. The salt, after being dried upon blotting paper, without the application of heat, should be preserved in a bottle.

PROPERTIES.—Emetic tartar crystallises in white, transparent, inodorous, rhombic octohedrons, whose lateral planes are striated (see fig. 132). By exposure to the air the crystals become opaque, probably by giving out an equivalent of water. Their taste is feebly sweetish, then styptic and metallic. They dissolve in 14 or 15 parts of water at 60° F. ($12\frac{83}{100}$ at 70°, Brandes), and in 2 parts ($2\frac{78}{100}$ parts, Brandes) at 212°. The aqueous solution slightly reddens litmus. Emetic tartar is not soluble in alcohol. When calcined in close vessels, it yields a pyrophoric alloy of antimony and potassium. The crystals decrepitate in the fire.

FIG. 132.

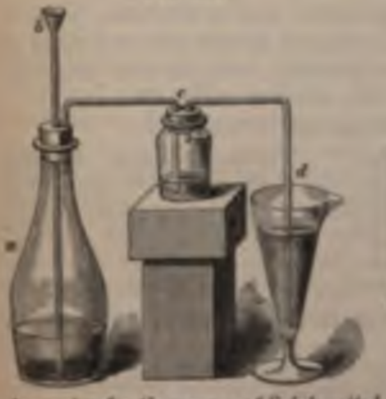


Octohedron of Emetic Tartar.

Characteristics.—Heated in a porcelain or glass capsule, this salt is charred, and evolves the peculiar caramel-like odour of burning tartaric acid. If the charred salt be heated in a glass tube by a blowpipe, globules of antimony are obtained. If the reduction be effected on charcoal, a portion of the metal is reoxidised, and deposited on the charcoal in the form of a white powder or crystalline needles (SbO^3).

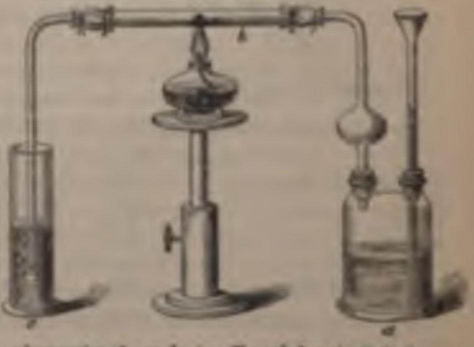
If a stream of hydrosulphuric acid gas, generated in the flask *a*, fig. 133, be

FIG. 133.



Apparatus for the passage of Sulphuretted Hydrogen through a Solution of Emetic Tartar.

FIG. 134.



Apparatus for reducing Tersulphuret of Antimony.

a. Vessel for generating hydrogen.
b. Reduction tube.
c. Vessel containing solution of acetate of lead to detect the hydrosulphuric acid which is formed.

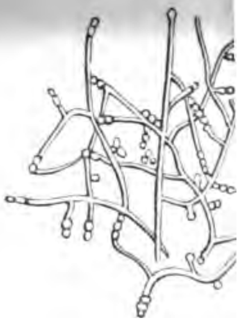
washed, by passing
conveyed into a solu
acid, and contained i
tersulphuret of anti
both in liquor amn
introduced into a g
over it, and, when
of a spirit-lamp app
are produced. (SbS
riously ?] sublimed.
it in nitro-hydrochlo
($SbCl^3,5SbO^3$) on t
with hydrosulphuric
reducing the tersulp
woodcut (fig. 134).

If the solution of
sulphuretted hydroge
of tartar,[1] $KO,\bar{T},HO$,

Hydrosulphuret of
tartar, an orange-red
excess of the precipit
whitish-yellow precipi

If emetic tartar be

FIG. 135.



Sirocrosis Stibica, Küt

COMPOSITION.—The

	At
Teroxide of Antimony	
Potash	
Tartaric Acid	
Water	
Emetic Tartar	

By many writers em
$KO,SbO^3,\bar{T},2HO$.

---

[1] Thomson's
[2] *Pharmaceut*

PURITY.—In the crystalline state, the purity of this salt is easily determined. The crystals should be well formed, perfectly colourless, transparent, or opaque, and, when dropped into a solution of hydrosulphuric acid, have an orange-coloured deposit (SbS^3) formed on them. When pure, the powder of this salt is perfectly white. Some ignorant druggists prefer a yellowish white powder; and I am informed by a manufacturer of this salt, that he is obliged to keep two varieties (one white, the other yellowish white) to meet the demands of his customers! The yellow tint is owing to the presence of iron, which is readily detected in the salt by the blue colour immediately produced in its solution by adding first a few drops of dilute sulphuric acid, and then ferrocyanide of potassium. [This test should not precipitate or in any way affect solution of the pure salt.—ED.]

Emetic tartar is sometimes adulterated with bitartrate of potash. According to the late Mr. Hennell,[1] the antimonial salt may contain 10 per cent. of bitartrate, and yet the whole will dissolve in the proper quantity (14 or 15 parts) of water. In order to detect any uncombined bitartrate, he adds a few drops of a solution of carbonate of soda to a boiling solution of the antimonial salt, and if the precipitate formed be not dissolved, he concludes that there is no bitartrate of potash present.

A dilute solution of emetic tartar occasions no precipitate with chloride of barium: it produces a white precipitate (unless the solutions be very dilute) with nitrate of silver, and which is soluble in excess of water.

Colourless, soluble in water. This solution is not altered by ferrocyanide of potassium. Hydrosulphuric acid being added, a reddish-coloured substance is precipitated; neither chloride of barium nor nitrate of silver being added throws down anything but what is again dissolved by the addition of water. That which is thrown down by nitric acid is redissolved by an excess of the same acid. From one hundred grains dissolved in water, hydrosulphuric acid precipitates forty-nine grains of tersulphuret of antimony.—*Ph. L.*

"Entirely soluble in twenty parts of water; solution colourless, and not affected by solution of ferrocyanide of potassium: a solution in forty parts of water is not affected by its own volume of a solution of eight parts of acetate of lead in thirty-two parts of water and fifteen parts of acetic acid."—*Ph. Ed.*

PHYSIOLOGICAL EFFECTS. α. *On Vegetables.*—Emetic tartar acts as a poison to plants.[2] The *Sirocrocis stibica*, however, grows luxuriantly in it (see *ante*, p. 744), and, therefore, forms an exception to this statement.

β. *On Animals.*—An extended examination of the effects of emetic tartar on the different classes of animals is still a desideratum. Hitherto experiments with it have been principally confined to dogs, rabbits, horses, oxen, sheep, and cats. Moiroud[3] has given two drachms to horses, and gradually increased the dose to six ounces, without perceiving any remarkable or permanent derangement in the exercise of the principal functions. Gilbert (quoted by Moiroud) has exhibited ten drachms to a cow, and four to a sheep, without any remarkable effect: but six drachms killed an animal of the latter species. Magendie[4] examined its effects on dogs. 'He found that from six to ten grains introduced into the stomach killed the animals in from two to three hours, when the gullet was tied: those who were able to get rid of it by vomiting took as much as a drachm without experiencing any bad

---

[1] Phillips's *Transl. of the Pharm.* 4th edit.

[2] Schübler and Zeller, in *Schweigger's Journ. f. d. Chem.* 1827, B. 50, S. 54-66.

[3] *Pharm. Vétér.* 287.

[4] Orfila, *Toxicol. Gén.*

effects, and in some c
ments it appears that
being on the intestin
tions, difficulty of re
injecting a solution
stomach, as well as b
Traces of pneumonia,
experiments have be
without obtaining th
cases no appreciable
by Dr. Christison) fo
salt. According to
causes efforts to vo
possessed by these an
by it. Orfila[3] has
emetic tartar had bee
in the liver, blood, a
γ. *On Man.* *aa*
tant. Its irritant pr
at least if we are to j
epidermis (as in the
It causes an eruptio
ecthyma. The smal
their height, are fla
contain a pseudo-mem
central dark point.
central brown spots b
takes place, and the
using the powder spr
applying the solution.
no agent which prod
tartar. The facility
individuals, and in
eruption has been me
from the internal use
observed on the velu
flammation of the th
the employment of an
We have further ev
in its action on the st
it gives rise to vomiti
death, redness of the
it would appear from
part of this effect sho

---

[1] *Dict de Méd. et de Chi*
[2] *Mémoires de l'Académi*
[3] *Journ. de Chim. Méd.*
the French Academy of Scie
[4] Lepelletier, *De l'Emploi*
[5] *Lond. Med. Gaz.* March

exerts over the stomach, independently of its direct local irritation, since the same symptoms have been induced by its application to wounds, and by its injection into the veins. Occasionally, constitutional effects (nausea, vomiting, and griping pains) have appeared to result from its application to the skin.[1] In one instance death resulted from its employment: the patient was an infant two years of age, and death occurred in forty-eight hours.[2] These effects, if really produced by this salt, occur very rarely. I have applied to the skin emetic tartar (in the form of solution, ointment, and plaster) in a very large number of cases, without having observed any constitutional effect; although I have occasionally fancied that it ameliorated pulmonary affections, even when no eruption or redness was produced, and which might arise from absorption.[3]

ββ. *Remote* or *constitutional effects.*—Taken internally, *in small doses*, emetic tartar increases the secretion and exhalation of the gastro-intestinal membrane, and of the liver and pancreas. Subsequently, it acts powerfully on other emunctories: thus it causes sweating, without any very marked vascular excitement; it renders the mucous membranes (especially the aërian membrane) moister, and, when the skin is kept cool, promotes the secretion of urine. These effects are produced more certainly and speedily by this salt than by any other antimonial preparation.

In somewhat larger doses, it excites nausea, frequently with vomiting, disorders the digestive functions, gives rise to an uneasy sensation in the abdominal region, depresses the nervous functions, relaxes the tissues (especially the muscular fibres), and occasions a feeling of great feebleness and exhaustion. These symptoms are accompanied or followed by increased secretion and exhalation from the different emunctories, but especially from the skin, as above mentioned. Of all emetic substances, this creates the most nausea and depression.

In excessive doses, emetic tartar has, in a few instances, acted as an irritant poison, and even occasioned death. In one case a scruple, in another 27 grains, nearly proved fatal.[4] In a third, 40 grains caused death.[5] The symptoms in the latter case were vomiting, hypercatharsis, convulsions, epigastric pain and tumefaction, and delirium. Death occurred four days after the ingestion of the poison. Were the above cases not well authenticated, we should be disposed to ascribe the dangerous symptoms and death to some other circumstance rather than to the use of the above-mentioned quantities of emetic tartar; for of late years this salt has been extensively employed in enormous and repeated doses with perfect safety. Rasori[6] has given many drachms in twenty-four hours, and many ounces during the course of a disease, without occasioning either vomiting or abundant alvine evacuations. Laennec[7] has confirmed, to a certain extent, the statements of Rasori. He gave a scruple, two scruples, and even a drachm and a half, within twenty-four hours (usually in doses of one, two, or three grains) without ever having

---

[1] *Journ. de Chimie Méd.* iv. 478.

[2] *Med. Repos.* xvi. 457.

[3] See also some experiments on this subject in *Mem. of the Med. Soc. Lond.* vols. ii, iv, and v.

[4] Orfila, *Toxicol. Générale.*

[5] *Ibid.*

[6] Bayle's *Bibliothèq. de Thérap.* i. 198.

[7] *Treatise on Diseases of the Chest*, by Dr. Forbes, p. 249.

seen any injurious c
from the continued
purging, which in n
the use of the medic
frequent effect. In
doses were administ
Now it is to this
ought to ascribe the
immense quantities
some remarks on th
if the opinion be w
increase as the disea
takes place. But in
have probably led hi
Laennec, "that afte
tolerance diminishes,
to find the patient b
that during convales
he will take daily,
grains of emetic tart
in both public and p
supporting Rasori's
becomes convalescen
individuals without a
Louis, a man who to
but suffered no rem
case of a girl who sw
diately given; vomiti
cases might be broug
but I must content n
a notice of them. I
concludes that the
evacuation of the salt
at least, of the cases,
happen: it was that
not vomit.

The action of large
tion is usually that of
constantly, observed.
six to eight grains rec
minute, and diminish
another, the pulse des

MODUS OPERANDI.
and may be detected
eliminated by the ur

---

[1] *Nouv. Elém. de*
[2] Orfila, *Toxicol.*
[3] *De l'Influence d*
[4] Bouneau et Con
[5] Trousseau, quot

Minaret[1] states, that a young woman labouring under pleuritis took emetic tartar, which operated on the child at her breast as well as on herself. It therefore probably existed in the milk. Several parts of the body are influenced by this salt. The specific affection of the *alimentary canal* (especially of the stomach) is shown by the vomiting[2] and purging produced, not only when the medicine is swallowed, but when it is injected into the veins or into the windpipe, or when applied to the serous coats of the intestines, or to the cellular tissue. If it purge, or occasion sweating, it usually causes thirst, but not commonly otherwise. The appetite and digestion are frequently unimpaired. After the use of it for some days, patients sometimes complain of irritation in the mouth and throat, with a metallic taste: this has been considered a sign that the system is saturated with antimony, and that the use of it should be suspended. A pustular eruption has occasionally appeared in the mouth, as I have already stated.

Magendie ascribes to emetic tartar a specific power of causing engorgement or inflammation of the *lungs;* for he found, on opening the bodies of animals killed by it, that the lungs were of an orange-red or violet colour, incapable of crepitating, gorged with blood, and here and there hepatised. Moreover, it has been assumed that the same effects are produced in the human pulmonary organs; and in support of this opinion, a case noticed by Jules Cloquet[3] has been referred to: it is that of a man who died of apoplexy, but who, within five days of his death, had taken forty grains of tartar emetic. "In the lungs were observed very irregular blackish spots, which extended more or less deeply into the parenchyma of this organ." Furthermore, it is argued, that unless we admit a specific influence of antimony over the lungs, we cannot well explain the beneficial effects of this remedy in peripneumonia. In opposition to this view I may remark, that in cases of poisoning by this substance in the human subject, no mention is made of the difficulty of breathing, cough, pain, or other symptom, which could lead to the suspicion that the lungs were suffering; and in the case of poisoning related by Recamier,[4] we are distinctly told that the thorax was sound. Besides, we should expect that if emetic tartar had a tendency to inflame the lungs, or at least to occasion pulmonary engorgement, that large doses of it would not be very beneficial in acute peripneumonia. It would even seem that this substance must have an influence over the human lungs of an opposite kind to that supposed by Magendie; for, as already related, it reduces the frequency of respiration in a considerable number of instances.

The sedative influence of emetic tartar over the *circulatory system* has been already noticed. The great depression of the muscular power, the diminution of the frequency of the pulse, and fainting, the epigastric pain sometimes experienced under circumstances that almost preclude the supposition of gastric inflammation, the cramps and convulsions, the delirium and insensibility, caused by emetic tartar in poisonous doses, are referrible to the influence of this substance on the *nervous system.*

The *absorbent system* is supposed to be stimulated to greater activity by emetic tartar, in consequence of the disappearance of serous and synovial

---

[1] *Lond. Med. Gaz.* xiii. 496.

[2] For some observations on the mode by which this salt induces vomiting, see p. 245.

[3] Orfila, *Toxicol. Générale.*

[4] Orfila, *op. cit.*

effusions under its
peripneumonia to th
The influence of
Every one is familia
best seen when the
supervene. Mage
and the same effect
The menstrual disc
under its use.

[Mr. Milton[4] has
inflammation of the
organ or beneath th

Dr. Langevin,[5] of
service in the gastr
quently met with a

USES.—As an *en*
it is sometimes use
When administere
two grains, frequent
When our object is
as little constitution
other emetics (as th
they occasion less
vomiting. On the
an impression on t
progress of a diseas
view that it is som
when accompanied
vomit, with conside
especially in croup,
also, the success of
croup it should be g
wards prolonged n
three slight cases c
agent. Dr. Coplan
most cases it will b
blood-letting. Dr.
second stage of cro
promoting the separ
to rely chiefly on c
blood-letting. Dr.
dissolved in a table-
of age every half ho

---

[1] Orfila, *op. cit.* p. 203
[2] I have already made s
[3] See *Liquefacientia*, p.
[4] *Lancet*, 1850, vol. i.
[5] *Bulletin Thérap. Mé*
[6] *Dict. of Pract. Med.*
[7] *Essay on Cynanche T*

hours after the last act of vomiting, the same process is to be recommenced, and so repeated while the strength will admit. Another disease which is relieved by the occasional use of emetics is *hooping-cough*. They should be administered at the commencement of the disease, every, or every other day. They diminish the violence and length of the fits of spasmodic coughing, and promote expectoration. Emetic tartar is particularly valuable in this disease, in consequence of being tasteless, and, therefore, peculiarly adapted for exhibition to children. In derangements of the hepatic functions, indicating the employment of emetics, this salt is usually preferred to other vomiting agents, on account of its supposed influence in promoting the secretion of bile.

Clysters containing emetic tartar have been employed to occasion vomiting, but they are very uncertain in their operation. Rayer has frequently employed from six to twelve grains without producing either nausea or vomiting.

It has been repeatedly *injected into the veins* to excite vomiting. The usual dose is two or three grains dissolved in two ounces of water; but in some cases six grains have been employed. The effects are unequal: when vomiting does occur it is not always immediate; frequently it does not take place at all.[1] In several cases of choking, from the lodgment of pieces of meat in the œsophagus, this remedy has been applied with great success: vomiting was produced, and with it the expulsion of the meat. It has also been tried in epilepsy and trismus; but frequently with dangerous consequences.[2] Meckel employed it to restore animation in asphyxia by drowning.[3] It has also been used in tetanus.[4]

As a *nauseant*, to reduce the force of the circulation and the muscular power, emetic tartar is frequently of considerable service. Thus, in dislocations of the larger joints (the hip and shoulder, for example), blood-letting, and nauseating doses of emetic tartar, are employed to diminish the resistance of the muscles opposing the reduction. Even in strangulated hernia it has been given.[5]

Emetic tartar, in large doses, is a most powerful and valuable remedy in the treatment of inflammation. On this subject I have already offered some remarks (see *ante*, p. 189.) As an emetic, nauseant, or diaphoretic, it has long been in use in peripneumonia; having been employed by Riverius in the 17th century, and subsequently by Stoll, Brendel, Schroeder, and Richter, in Germany; by Pringle, Cullen, and Marryat, in England. But as a remedy for inflammation, independent of its evacuant effects, we are indebted for it to Rasori,[6] who first used it in the years 1799 and 1800, in an epidemic fever which raged at Genoa. Subsequently he exhibited it much more extensively, and in larger doses, in peripneumonia. This mode of treatment was tried and adopted in France, first by Laennec;[7] and in this country by Dr. Balfour.[8] Its value as an antiphlogistic is now almost universally

---

[1] Dieffenbach, *Transf. d. Blut. u. d. Infus. d. Arzn.*

[2] *Ibid.* p. 49.

[3] *Ibid.*

[4] *Lancet* for 1836-37, vol. i. p. 35.

[5] *Ibid.* p. 876.

[6] See the French translation of his Memoir, in Bayle's *Biblioth. de Thérap.* i. 198.

[7] *Treatise on Diseases of the Chest*, translated by Dr. Forbes.

[8] *Illustrations of the Power of Emetic Tartar*, 2d edit. 1819.

admitted. Practitio
of using it. Raso
Mackintosh,[6] Drs. G
of this country, emp
the use of emetic ta
tion of blood is con
advises on no accou
letting, far from aid
most practitioners,
antiphlogistic influe
rical results of the
and by emetic tart
large doses, where b
action, and appeared
that blood-letting m

Laennec's mode
I believe to be the
one grain of emetic
fluid [cold weak inf
syrup of marshmall
and then suspended
or if there be any in
progress, or if the
medicine until amen
to two, or two and
I would venture to
one-third or one-half
of the violent vomiti
patients positively r

From my own ex
viceable when it c
occasions no evacua
emetic tartar is nev
to no evacuation; s
by a general perspir
no means desirable,
intestinal canal whi
in cases in which s

---

[1] *Op. cit.*
[2] *Op. cit.*
[3] *Gazette Médical*
[4] *Cours de Pathol*
[5] *Dictionnaire de*
[6] *Practice of Phy*
[7] *Dublin Hospital*
[8] *Lectures on Dis*
[9] Bayle, *Bibliothè*
[10] *Dictionnaire de*
[11] *Recherches de la*
[12] *Op. cit.* p. 62.
[13] *Op. supra cit.* p.

of tincture of opium may be sometimes conjoined with the antimony, to check its action on the alimentary canal.

The attempts which have been made to explain the *modus medendi* of emetic tartar in pneumonia and other inflammatory diseases are most unsatisfactory. Whilst almost every writer, even Broussais, admits its efficacy in inflammation, scarcely two agree in the view taken of the mode by which its good effects are produced, as the following statement proves:—Rasori explains its operation according to the principles of the theory of contra-stimulus,[1] of which he may be regarded as the founder. He considers emetic tartar endowed with the power of directly diminishing the inflammatory stimulus; of destroying the diathesis, and of being, therefore, a real contra-stimulus. Broussais, Bouillaud, and Barbier, ascribe its curative powers to its revulsive or derivative action on the gastro-intestinal membrane. Laennec thinks that it acts by increasing the activity of interstitial absorption. Fontaneilles supposes that the antiphlogistic effect depends on alterations in the composition of the blood. Eberle[2] refers it to the sedative effects, first, on the nervous system, and consecutively on the heart and arteries. Tealer thinks that, like many other therapeutic agents, it influences the organism by concealed curative properties. Dr. Macartney[3] regards it as a medicine diminishing the force of the circulation, by the nausea which it occasions. These examples are sufficient to show the unsatisfactory condition of our present knowledge as to the mode by which emetic tartar produces its curative effects.[4] But this is no argument against the existence of remedial powers. Shall we deny the efficacy of blood-letting in inflammation, of mercury in syphilis, of cinchona in intermittents, of arsenic in lepra, of sulphur in scabies, of hydrocyanic acid in gastrodynia, and of a host of other remedies, simply because we cannot account for their beneficial effects? The fact is, that in the present state of our knowledge we cannot explain the *modus medendi* of a large number of our best and most certain remedial means.

In *pleurisy*, emetic tartar does not succeed so well as in inflammation of the substance of the lungs. "It, indeed, reduces speedily the inflammatory action," says Laennec,[5] "but when the fever and pain have ceased, the effusion does not always disappear more rapidly under the use of tartar emetic than without it." I have sometimes conjoined opium (always after copious blood-letting) with advantage. In *bronchitis* (both acute and chronic), it may be most usefully employed in conjunction with the usual antiphlogistic agents.[6] In *rheumatism* (especially the kind called *articular*), next to peripneumonia, emetic tartar has been found by some practitioners (especially by Laennec[7]), more efficacious than in any other inflammatory affection: the usual duration of the complaint, when treated by this remedy, was found by Laennec to be seven or eight days.[8] In muscular rheumatism it succeeds less perfectly. Synovial effusions (whether rheumatic or otherwise) have, in some cases, given way rapidly to the use of emetic tartar.[9] In *arachnitis*, Laennec has seen all the symptoms disappear, under the use of emetic tartar, in forty-eight hours. In three instances of acute hydrocephalus, all the symptoms disappeared in the same space of time. In *phlebitis*,[10] in *inflammation of the mammæ* occurring after delivery,[11] in *ophthalmia*, and various

---

[1] See *ante*, p. 100, *et seq.*

[2] *Materia Medica*, t. 66.

[3] *A Treatise on Inflammation*, 1838.

[4] See p. 179, for some observations on the curative agency of resolvents.

[5] *Op. cit.* p. 259.

[6] *Vide* also Dr. Kemp, *Lond. Med. Gaz.* xix. 300; and Mr. Ellis, *op. cit.* p. 369.

[7] *Op. cit.*

[8] See also Bayle's *Bibl. Thérap.* t. 311; and Lepelletier, *De l'Emploi du Tart. Stib.* p. 220.

[9] Laennec, *op. cit.* p. 263; and Gimelle, *Brit. and For. Med. Rev.* for July 1838, p. 224.

[10] Laennec, *op. cit.*

[11] Dr. E. Kennedy, Mr. Lever, and Dr. Ashwell, *Lond. Med. Gaz.* xx. 761.

other inflammatory
an antiphlogistic.

In *continued fe*
by the use of small
diaphoretic. In
much vascular exci
may be usefully ac
general, be preced
fever, accompanied
sleep, delirium, &c
the use of emetic
ployed with great
sipelas, scarlatina,

Dr. Billing[3] reg
regards its epidemi
ague of a fresh typ
tarised antimony w
ordered two grains
in half a pint of w
patient recovered.

Emetic tartar is
available when othe
we are desirous of
are accompanied wi
opiate sudorifics (
whereas emetic tart
to increase disorder
On the other hand
narcotic sudorifics

As an expector
salt are frequently

In some spasmo
instances in which
been employed to d
vomiting renders it
with benefit by Mr.

The internal emp
advocated by Mr. S

As a local irritan
aqueous solution, o
catories, over which
organs. When it
are in some cases
with the greatest ac

---

[1] *Lond. Med. Gaz.* xx

[2] *Ibid.* xviii. 538 and

[3] *First Principles of*

[4] *Vide* Laennec, *op.*
Med. Gaz. xxi. 56.

[5] *Medical Times and*

[6] *Lond. Med. Gaz.* vol

blisters. In employing it, one part of the chest may be rubbed until the eruption is produced; and then, after the interval of a day or two, another part: thus keeping up irritation by a succession of applications to different parts of the chest for several months. In this way it is found to be most serviceable in chronic catarrhs, peripneumonias, and pleurisies. Even in lingering phthisis I have seen the cough and pain alleviated by the occasional use of antimonial frictions. The objection to its use is the painful character of the eruptions. In *hooping-cough* it is also serviceable. Autenrieth recommended it as a means of diminishing the frequency of the paroxysms and the violence of the cough. In *laryngitis* it is occasionally of great service; as also in various *affections of the joints*, especially chronic inflammation of the capsular ligament, or of the synovial membrane, hydrops articuli, particularly when connected with inflammation, and tumors of various kinds about the joints. In *tic douloureux*[1] it has also been employed with benefit. In the *paralysis* of children, the region of the spine should be rubbed with the ointment. Its effects are most beneficial, especially where one leg only is affected. It is sometimes necessary to keep an eruption out for many weeks. In *hysteria*,[2] the same application to the spine has been found serviceable.

[Tartar emetic ointment applied to the scalp has been employed in *tubercular meningitis* by Dr. Harn,[3] of Aix-la-Chapelle. Internal remedies are not excluded in the outset of the disease; but it is to the revulsive action of the tartar emetic ointment that Dr. Harn looks as the most powerful means of obtaining absorption of the morbid products. The ointment is gently applied to the shaven scalp every two hours until the eruption appears. Its employment need not interfere with the application of cold to the head. Great pain is often caused, suppuration frequently follows, and it may be many weeks before cicatrisation is complete. The urgency of the case excuses the severity of the treatment, in the opinion of Dr. Harn. When, however, the symptoms yield shortly after the application, it can be withheld, and the progress of pustulation retarded by cold applications.—ED.]

A *stimulating wash*, composed of one scruple of tartar emetic to an ounce of water, was proposed by the late Sir William Blizard, in the year 1787, to cleanse foul ulcers, repress fungous growths and venereal warts, and as a local application in tinea capitis. A weak solution (as half a grain to the ounce of water) has been employed as a stimulant in chronic ophthalmia, and in spots on the cornea.

ADMINISTRATION.—The dose of emetic tartar, *in substance*, is, as a diaphoretic and expectorant, $\frac{1}{12}$ to $\frac{1}{6}$ of a grain; as a nauseant, from $\frac{1}{4}$ to $\frac{1}{2}$ a grain; as an emetic, from 1 to 2 grains; as an antiphlogistic, from $\frac{1}{2}$ a grain to 3 or 4 grains. This salt is, however, rarely employed in substance. Sometimes a grain of it, mixed with ten or fifteen grains of powdered ipecacuanha, is employed as an emetic. A mixture of one grain with sixteen grains of sulphate of potash may be employed, in doses of from two to four grains, as a substitute for antimonial powder, to promote diaphoresis.

In *solution*, it is commonly employed as an expectorant, diaphoretic, nauseant, or emetic, in the form of antimonial wine. When used as an

---

[1] Hombrandt, *British and Foreign Medical Review*, Jan. 1837, 230.

[2] Tate, *A Treatise on Hysteria*, Lond. 1830.

[3] *Bulletin Thérapeut.* t. xxxvii. p. 54.

antiphlogistic, an a
it should be made
flask).

For external use
ment, or *plaster*.
prepared by pourin
emetic tartar, and
will be found pref
and cleanest. An
sprinkling from ten
Burgundy pitch pl

Antidote.—Pr
said to be tannic a
bark, tea, nutgalls,
other preparations
tartar, it does no
Dispensary, I saw
or decoction of yell
and in almost ever
of Laennec,[2] as w
valuable agent for
warm bath have be

1. VINUM ANTIM
E.; *Antimonii T*
Tartar, ℈ij; She
Distilled Water, O
antimony in the wa
filter, add the spirit
—Each fluidounce
that Sherry, and n
frequently contains
the wine be good,
unless it be kept fo
The Dublin formul

Antimonial wine
ten to thirty drops
drachms; as an em
intervals of about
is produced: as an
and as an antiphlog
an ounce; but for
aqueous solution is

2. UNGUENTUM A
moniale, E.; *Ung*
Ointment. (Emet
L. E. The *Dublin*

---

[1]
[2]
[3]

Ointment of White Wax.)—In the preparation of this ointment it is important that the emetic tartar be in the state of a very fine powder, in order to avoid the irritation produced by rubbing gritty particles on the skin. A portion of ointment, about the size of a small nut, is to be rubbed on the skin night and morning. After the use of it for two or three times, the painful condition of the part thereby induced commonly prevents further employment of friction. It is sometimes applied, spread on linen, without rubbing. By either of these methods a crop of painful pustules is produced: but the facility and rapidity with which they are developed, varies considerably in different individuals. Occasionally, adventitious eruptions have appeared in other parts of the body, which have been ascribed to absorption of antimony into the system.[1] But I believe with Rayer,[2] that they arise from the inadvertent application of the ointment to these parts. This ointment is used as a counter-irritant in various chronic maladies: thus it is applied to the chest in pulmonary affections, and to the joints in chronic diseases (whether rheumatic or otherwise). It should only be applied to sound portions of the skin, and, therefore, leech-bites, the scarifications from cupping, and wounds, are to be carefully avoided; for severe inflammation, and even gangrenous ulceration, may be produced by not attending to this caution. I have before mentioned, that in a very few cases severe and even fatal constitutional disorder has appeared to have resulted from the use of antimonial ointment.

ORDER XXII. BISMUTH AND ITS COMPOUNDS.

114. BISMUTHUM.—BISMUTH.

Symbol Bi. *Equivalent Weight* 213.

HISTORY.—This metal is first mentioned by Agricola, in 1529. It has been termed *marcasita, tectum argenti*, or, by the Germans, *wismuth*. "The old miners call it wismuth," says Matthesius, "because it blooms like a beautiful meadow (*wiesematte*), on which variegated flowers of all kinds are blooming."[3]

NATURAL HISTORY.—Bismuth occurs only in the mineral kingdom. It is found in Cornwall, Saxony, Bohemia, the United States, and other localities. It is met with in the metallic state nearly pure (*native bismuth*), and in combination with sulphur and with oxygen.

PREPARATION.—It is chiefly obtained from native bismuth by melting the metal out of its gangue.

PROPERTIES.—It is a reddish-white metal, without taste or smell, composed of brilliant broad plates, and readily crystallisable in cubes or regular octohedrons (figs. 136 and 137). It belongs, therefore, to the regular system. The sp. gr. of purified bismuth is, according to Karsten, 9·6542; that of commercial bismuth, according to Herapath, 9·833. It is moderately hard, brittle, pulverisable, fusible at 476° F. When strongly heated in the air, it

---

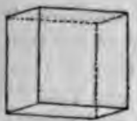
[1] *Gaz Méd.* 1832, p. 842.

[2] *Treatise on Diseases of the Skin*, by Dr. Willis, p. 540.

[3] Schwartze, *Pharm. Tabellen.*

takes fire, and burn
In close vessels it m

Fig. 136. Fig



Cube.

Oct

Purity.—Copper
solution with ammo

Its specific gravity is
Its powder is entire
colourless, or nearly so,
—*Ph. Ed.*

Physiological E
Its only use in phar

115. BISMUT

For

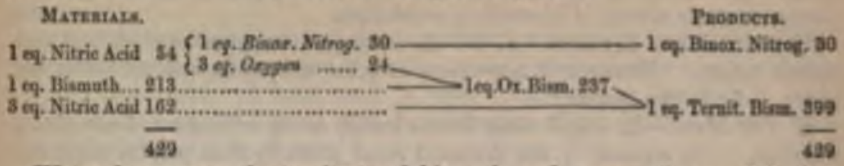
History.—This
various appellations,
for submuriate of b
trisnitrate of bism
nitras), or *white bi*

Preparation.—A
of this salt.

The *London College* o
Mix a fluidounce of th
mixture; then pour off
the powder may subside
Trisnitrate of Bismuth v
The process of the *Ed*
nitrate] is directed to b
and dried in a dark plac
The *Dublin College*
ments, ℥ij.; Pure Nitric
with three ounces of th
when the spontaneous a
of ebullition, decant the
Evaporate the solution a
pour it into half a gallon
decant the supernatant l
After twelve hours, agai
temperature of 212°, and

In the first part of
reaction of an equival

equivalent of binoxide of nitrogen is evolved, and an equivalent of ternitrate of bismuth formed. $Bi+4NO^5=BiO^3,3NO^5+NO^2$.



Water decomposes the ternitrate of bismuth, and causes the precipitation of the nitrate (also called subnitrate, or trisnitrate), leaving a supernitrate in solution. $4(BiO^3,3NO^5)+HO=3(BiO^3,NO^5,HO)+BiO^3 9NO^5$.

[The proportion of water in the compound affects its strength: this is liable to great variation. Mr. Edwards,[1] at a meeting of the Liverpool Chemists' Association, in March 1850, stated that he had found the following variations in six samples obtained from respectable houses in London and Liverpool:—

	No. 1. Per Centage.	2.	3.	4.	5.	6.
BiO^3	77·23	79·4	87·46	88·1	73·4	80·08
NO^5	16·2	13·8	2·32	10·	16·38	18·5
Aq.	6·	6 6	10·1	1·6	9·5	1·3
	99·43	99·8	99·88	99·7	99·28	99·88—ED.]

PROPERTIES.—It is a dull white, inodorous, tasteless pulveriform substance, which, when examined by a magnifier, is found to consist of very fine silky acicular crystals. It is nearly insoluble in water, but is readily dissolved by nitric acid. By exposure to light it becomes greyish.

Characteristics.—Hydrosulphuric acid, or the hydrosulphates, blacken it, by forming the tersulphuret of bismuth (BiS^3). It dissolves in nitric acid without effervescence. Heated on charcoal by the blow-pipe flame it gives out nitrous acid (or its elements), and yields the yellow oxide of bismuth (BiO^3); and, by a continuance of the heat, the oxide is reduced, globules of metallic bismuth being obtained, which may be readily distinguished from globules of lead by their brittleness; for, when struck sharply by a hammer on an anvil, they fly to pieces: from antimony they are distinguished by their solubility in nitric acid.

COMPOSITION.—Nitrate of bismuth has the following composition:—

	At.	*Eq.Wt.*	*P.Ct.*	*Herberger.*	*Duflos.*	*Grouvelle.*	*Phillips.*[2]	*Menigaud.* (Dried at 212°.)
Teroxide of bismuth	1	237	79	79·70	80·00	81·37	81·92	85·33
Nitric acid	1	54	18	14·44	13·58	13·97	18·36	14·67
Water	1	9	3	5·86	6·42	4·66	0·00	0·00
Nitrate of Bismuth	1	300	100	100·00	100·00	100·00	100·68	100·00

PURITY.—Its freedom from any carbonate (as of lead) is known by its solution in nitric acid without effervescence. Diluted sulphuric acid added to the solution throws down a white precipitate, if lead be present.

It is soluble in nitric acid without effervescence. Diluted sulphuric acid being added to the solution, nothing is thrown down.—*Ph. Lond.*

It forms a colourless solution with nitric acid and without effervescence: not subject to adulteration."—*Ph. Ed.*

---

[1] *Pharm. Journ.* 1849-50, p. 461.

[2] *Phil. Mag.* Dec. 1830, p. 409.

The microscope w
by adding an alkali
phous, whereas nitr

Physiological E
caustic poison. M
lungs and nervous s

β. On Man.—L
secretion. On acco
of the stomach, it is
It has also been den
used as a cosmetic, i
in paralysis.

Large medicina
vomiting, purging,
producing giddiness,
other hand, M. Mon
that it may be given
that it is then of th
those attended with

The following is t
took two drachms b
dition to the usual s
tion of the nervous sy
vision, and delirium.
of breathing, and sal
throughout the alime
particularly towards t
tricles; and the inn
(Christison). [In a
drachms of the subn
vomiting and pain in

An out-patient unc
for a stomach affectio
hydrocyanic acid, for
ever: on the contrary

Use.—It has been
stomach which are u
rently depend on son
and hence the efficac
these parts. It has
gastrodynia and cram
a remedy for pyrosis o
form of a powder, in d
acid mixture, and th
its use. Dr. Theophi
usually combined with

---

[1] Orfila, *Toxi*
[2] *Pharmakod*
[3] *Edinburgh*
[4] *Medico-Chi*

four or six hours, in the diarrhœa accompanying phthisis. He thinks that, both in efficacy and safety, it surpasses our most approved remedies for that complaint.

It has also been administered in intermittent fever, and in spasmodic asthma. Hahnemann has recommended a portion to be introduced into a hollow tooth, to allay tooth-ache. I have used it, with advantage, in the form of ointment, applied to the septum nasi, in ulceration of this part, and as a local remedy in chronic skin diseases.

ADMINISTRATION.—The usual dose of this remedy is from five grains to a scruple. I seldom commence with less than a scruple, and have repeatedly exhibited half a drachm without the least inconvenience. It may be administered in the form of powder, linctus, or pill. The *ointment* which I have above referred to was composed of one drachm of the nitrate, and half an ounce of spermaceti ointment.

ANTIDOTES.—No chemical antidote is known. Albuminous and other emollient drinks, as milk, should be administered, and the poison evacuated from the stomach as speedily as possible. The antiphlogistic plan is to be adopted, to obviate inflammation.

ORDER XXIII. ZINC AND ITS COMPOUNDS.

116. ZINCUM.—ZINC.

Symbol Zn. Equivalent Weight 32·5.

HISTORY.—Although the ancients were acquainted with the method of converting copper into brass by means of an ore of zinc, yet we have no positive evidence that they knew metallic zinc, one of the constituents of this alloy. Perhaps the *false silver*, or ψευδάργυρος of Strabo, may have been zinc, which is said to have been known from time immemorial in China and India. Albertus Magnus, who died in 1280, is the first writer who expressly mentions this metal.[1]

It has had various appellations; such as *contrefeyn golden marcasite. Indian tin* (*stannum Indicum*), *spiaulter*, *speltre* or *spelter* (*speltrum*).

NATURAL HISTORY.—It occurs only in the mineral kingdom. It is found in the form of oxide (*red zinc*), of sulphuret (*blende* or *black jack*), of carbonate (*calamine*), of sulphate (*white vitriol*), of silicate (*electric calamine*), and aluminate (*automalite* or *gahnite*).

PREPARATION.—Zinc is usually procured from the native sulphuret or carbonate of that metal. It may also be obtained from the silicate.

The picked ore, being broken into small pieces, is submitted to a dull red heat in a reverberatory furnace. By this process the sulphur of the sulphuret is transformed into sulphurous acid, which escapes, and the zinc is oxidized; while the carbonate loses carbonic acid and water. The resulting oxide is then mixed with some carbonaceous substance (small coal or charcoal), and submitted to heat, by which the metal is reduced and vaporized. Sometimes

---

[1] Beckmann, in his *History of Inventions and Discoveries*, vol. iii. p. 71, has given a good account of the history of zinc.

the reduction is
which is perforat
situated in an ap
escape by this tu
distillatio per d
employed.[1]

The Bristol an
from the Mendi
Zinc is also impo
Antwerp, and D

PROPERTIES.—
tallises in four-si
line. Its sp. gr.
from 212° to 30
thin leaves (*shee*
powder. It rea

Characteristi
of hydrogen gas.
nous white pre
present the pre
phuret of ammo
(ZnS), which is
iron be present,
throw down a w
potash occasions
$2(ZnO, CO^2)$.

PURITY.—Con
it (L. Gmelin) :—

Zinc ....
Lead ....
Cadmium ..
Iron ....
Carbon .....

When commer
any iron which
stance, which, a
carbon; but, acc
and iron.

Its specific gravit
down from this solu

It dissolves in a
black residuum : th
the solution of sulp

[The oxide bec
nearly reacquires

---

[1] Dumas, *Traité de*

The ready solubility of commercial zinc in dilute sulphuric acid depends greatly on its impurity; for absolutely pure zinc is comparatively feebly acted on by this dilute acid.

To prevent what is termed the *local action* of sulphuric acid on the zinc, arising from the impurity of this metal, the plates of zinc employed in Daniell's, Grove's, and Smee's voltaic batteries are amalgamated.

PHYSIOLOGICAL EFFECTS.—In the *metallic* state zinc is inert. The *compounds of zinc* are somewhat analogous in their action on the system to those of copper, silver, and bismuth, but are much less energetic. They act topically, according to their degree of concentration, as desiccants, astringents, irritants, and caustics. Taken internally, they excite, more or less readily, nausea and vomiting; and in large doses operate as irritant and caustic poisons. They exercise a specific influence over the nervous system, although this is much less obvious than in the preparations of the other metals just referred to. The stupor and inactivity, mentioned by Orfila[1] as being produced by the sulphate, are evidence of the affection of the nervous system. The antispasmodic power evinced by zinc, in certain diseases, can only be explained by referring it to the action of this metal on the nervous centres.

USES.—As *topical* agents we employ the compounds of zinc as caustics, astringents, and desiccants. Thus the chloride is used as a caustic; the sulphate and acetate as astringents; and the oxide and carbonate as desiccants. [Dr. Bonnewin,[2] of Tirlemont, has found that in catarrhal ophthalmia, and other inflammations attended with muco-purulent secretion, the *tannate of zinc* was an efficacious collyrium, in the proportion of two grains to six ounces of water.—ED.]

Internally, the compounds of zinc are administered in large doses to excite vomiting; in smaller doses as tonics and antispasmodics in intermittent diseases and chronic affections of the nervous system.

The chloride is used as an antiseptic.

117. ZINCI OXYDUM.—OXIDE OF ZINC.

Formula ZnO. *Equivalent Weight* 40·5.

HISTORY.—The oxide was first prepared by Hellot in 1735. When obtained by burning metal in the air it has received various names, some of them of a fantastic nature; as *nihil album*, *philosopher's wool* or *lana philosophica*, *pompholyx*, and *flowers* or *calx of zinc* (*flores* seu *calx zinci*).

NATURAL HISTORY.—Oxide of zinc is found in America, mixed or combined with the sesquioxide of manganese, and constituting the *red oxide of zinc* of the mineralogist. It is also found in various localities, in combination with carbonic, sulphuric, or silicic acid.

PREPARATION.—All the British Colleges give directions for the preparation of this compound.

The *London College* orders of Sulphate of Zinc, lb. j.; Sesquicarbonate of Ammonia, ℥viss.; Distilled Water, *Cong.* iij. Dissolve the Sulphate of Zinc and Sesquicarbonate of

---

[1] *Toxicol. Générale.*

[2] *Journal de Chimie*, 1853, p. 442.

Ammonia separately, in
what is precipitated fr
strong fire.
The *Edinburgh Colleg*
The process is otherwise

By the mutual rea
sulphate of ammonia
$3(ZnO,HO)+3(ZnO$
carbonic acid and wa

The *Dublin College* dir
of Zinc any convenient
expose it to a very low r
from its centre, ceases t

In this process the c
A manufacturing
that he obtained it f
from the workers of
zinc and some caustic
then added a solution
basic carbonate of zi
oxide of zinc
[Mr. Midgley[1] has
zinc by combustion, w
rienced in carrying on
heated to redness in a f
water in which that p
air is detained. This
and more efficacious t
Pharmacopœias.—Ed.
PROPERTIES.—The
the oxides of iron and
The artificial oxide
yellowish-white, taste
glass, and at a white
readily reduced. It is
[in the hydrated state
quicarbonate of amm
zincic salts), in which
part of an acid.
Characteristics.—
of the solution have be
COMPOSITION.—Oxi

Zinc ....
Oxygen ....

Oxide of Zinc ......

PURITY.—Pure oxid

---

sulphuric, nitric, or hydrochloric acid, without effervescence. The substance met with in the shops under the name of oxide of zinc is in reality a carbonate of this metal containing a variable quantity of oxide, and, therefore, it effervesces on the addition of an acid. The solution obtained by dissolving the oxide in any of the above acids yields a precipitate, on the addition of caustic ammonia or potash, which should be completely soluble in an excess of the precipitant. The oxide of zinc of the shops sometimes yields traces of sulphuric acid when its solution in nitric acid is tested with a salt of baryta.

The oxide of lead or cadmium is sometimes found in it, and the oxide of cadmium was once mistaken for arsenious acid.[1] Iron and manganese may be present in oxide of zinc, and communicate to it a yellow tinge The oxide is,—

A yellowish white powder soluble in ammonia, potash, and hydrochloric acid.—*Ph. Lond.*

White: tasteless: entirely soluble in diluted nitric acid without effervescence: this solution is not affected by nitrate of baryta, but gives with ammonia a white precipitate entirely soluble in an excess of the test.—*Ph. Ed.*

[When the oxide of lead or cadmium is present the precipitate first formed by sesquicarbonate of ammonia in the acid solution of the oxide is not entirely redissolved by an excess of the precipitant. If oxide of cadmium be the impurity, sulphuretted hydrogen water gives a yellow tint: if oxide of lead be present, this gas blackens the solution. It should be remembered that the latter impurity may really be present in the sesquicarbonate, and not in the oxide of zinc, since leaden receivers are employed in the manufacture of the sesquicarbonate of ammonia.—ED.]

PHYSIOLOGICAL EFFECTS. α. *On Animals.*—Orfila[2] gave from three to six drachms of it to small and weak dogs: they were attacked with vomitings, without suffering much.

β. *On Man.*—Applied to ulcerated or other secreting surfaces, it acts as a desiccant and astringent substance. On account of its insolubility, the absorption of it must be very slow. Taken into the stomach in large doses, it acts as a slight irritant, and provokes vomiting, and sometimes purging. It is said to have also caused occasional giddiness and temporary inebriation. In small doses it may be taken for a considerable period without causing any obvious effects. Sometimes, under its employment, certain affections of the nervous system (as epilepsy, chorea, &c.) subside; from which we infer that it exercises some specific influence over this system; and it is, therefore, termed tonic, antispasmodic, and sedative. But the nature of its influence is not very obvious. By long-continued use it acts as a slow poison, and produces *tabes sicca.* A gentleman, for the cure of epilepsy, took daily, at an average, twenty grains of oxide till he had consumed 3246 grains, which must have taken him about five months. At the end of this time he was found of a pale, earthy hue, wasted away, and almost idiotical: his tongue was thickly coated, the bowels were constipated, the inferior extremities cold and œdematous, the abdomen tumid, the superior extremities cold and shrivelled, and their skin dry, like parchment: the pulse was about sixty, thready, and scarcely perceptible. Under the use of purgatives, a light nutritive diet, with tonic and diuretic medicines, he rapidly recovered, but he remained subject to epileptic attacks.[3]

USES.—*Internally* it has been commended in some spasmodic diseases, viz., epilepsy, chorea, hysteria, catalepsy, and hooping-cough ; and in painful affections, as neuralgia and gastrodynia. Though occasionall viceable in some of these maladies, it has so frequently failed, that practit have ceased to place much confidence in it. [Oxide of zinc has been of great service, in five-grain doses, combined with extract of henbane or lock, in colliquative perspiration.—Ed.]

---

[1] Thomson, *Hist. of Chem.* ii. 219.

[2] *Toxicol. Gén.*

[3] *Brit. and For. Med. Rev.* July 1838, p. 221.

Externally, it is employed in the form of powder, lotion, or oint As a *dusting powder* it is useful, by its mild, absorbent, and desiccan perties, and is applied to impetiginous, eczematous, and other chronic di of the skin, attended with profuse secretion. It is also used to allay or p excoriation in children and bedridden persons, and to remove chaps and of the nipples. In painful ulcers, with copious discharge, it is not quently beneficial by its desiccant and sedative properties. *Diffused th water* or a *mucilaginous solution* (in the proportion of two drachms oxide to six or eight ounces of liquid), it is occasionally useful in c ophthalmia, especially *ophthalmia tarsi*, and in eczema. Sommé[1] em an injection, composed of half an ounce of oxide and two pints of wat gonorrhœa and leucorrhœa, with success.

Administration.—Internally, it is administered in the form of p powder, in doses of from two or three grains gradually increased to ten, or more.

1. **UNGUENTUM ZINCI**, L. E.; *Unguentum Zinci Oxydi*, D.; *Zinc ment.* (Oxide of Zinc, ℥j.; Lard, ℥vj. M. *L.* The *Edinburgh C* substitutes Simple Liniment for Lard. The *Dublin College* gives th lowing directions: Take of Oxide of Zinc, ℥ij.; Ointment of W Wax, ℥xii.: melt the ointment with a gentle heat, and having oxide of zinc, mix them intimately, and stir constantly until the mixture cretes. M.)—This compound is employed as a mild drying ointment in rigo, impetigo, and other skin diseases attended with profuse discharges, extensive burns, blisters, sinapisms, &c.; to painful ulcers with excessiv cretion, to the eye when affected with chronic inflammation, &c.

2. **ZINCI OXYDUM IMPURUM**; *Impure Oxide of Zinc.*—This substan known in the shops under the name of *tutty*, (*tutia* seu *tuthia*), or *fur cadmia* (*cadmia fornacum* seu *factitia*). It is found in the chimne the furnace in which zinc ores are roasted, or in which zinciferous lead are smelted. When prepared by levigation and elutriation it is called *pared tutty* (*oxydum zinci impurum præparatum ; tutia præparata*). is applied as a dusting powder, or as a cooling ointment (*unguentum o. zinci impuri*); composed of Simple Liniment or Lard, 5 parts; Tutty, 1 M.) to excoriated surfaces.

118. ZINCI CARBONAS.—CARBONATE OF ZINC.

Formula ZnO,CO^2. *Equivalent Weight* 62·5.

History.—The native carbonate of zinc (*zinci carbonas nativa, usta, pulverem subtilissimum trita, et elutriata,* L) was perhaps known to ancients, although they were unacquainted with its nature. The term *calamine* (*calamina*) is applied both to the native carbonate and native silicate of zinc: the latter is called, by way of distinction, *electric calamine*.

---

[1] *Archiv. Gén. de Méd.* i. 486.

NATURAL HISTORY.—Native carbonate of zinc, or calamine, is found in great abundance in several parts of England (in the counties of Somerset, Derby, Durham, &c.) as well as in various parts of the continent of Europe (in Carinthia, Hungary, Silesia, &c.) It occurs crystallised or in compact or earthy masses. Its colour varies, being more or less grey, yellow, or brown. Its sp. gr. is 4·2 to 4· 5.

PREPARATION.—Calamine (*calamina*), or the impure carbonate of zinc is directed to be calcined, in order to make it pulverizable. But in this process water, and more or less of the carbonic acid, is expelled. It is then reduced to a very fine powder (usually in mills), and is afterwards submitted to the processs of elutriation. By this means we obtain *prepared calamine* (*Calamina præparata*, L. E.) Native calamine varies so considerably in its colour, owing to the admixture of foreign bodies, that the *prepared calamine* obtained from it cannot be uniform in its appearance. It is owing, probably, to this, and the desire to obtain a preparation of uniform colour, that a factitious is usually substituted in the shops for the genuine article.

Genuine prepared calamine is a greyish, yellowish, pinkish, or brownish powder. If quite pure—that is, composed of carbonate of zinc only—it is completely soluble, with effervescence, in nitric, hydrochloric, or sulphuric acid. Some of the accidental impurities in it are insoluble in these acids. The prepared calamine usually found in the shops is in the form of a heavy pinkish or flesh-coloured powder, or made up into little masses.

Characteristics.—The effervescence with the mineral acids shows calamine to be a carbonate. The presence of zinc in the solution is determined by the tests before mentioned for this metal. The action of the tests, however, is more or less impeded by the presence of foreign matters in calamine.

COMPOSITION.—Carbonate of zinc has the following composition:—

				Smithson.		
	Atoms.	*Eq. Wt.*	*Per Cent.*	(Mendip Ore.)		(Derbyshire Ore.)
Oxide of Zinc	1	40·5	64·8	64·8	to	65·2
Carbonic Acid	1	22·	35·2	35·2	to	34·8
Carbonate of Zinc	1	62·5	100·0	100·0	to	100·0

IMPURITIES.—The substance sold in the shops as prepared calamine frequently contains only traces of oxide or carbonate of zinc. If hydrochloric acid be poured on it, effervescence (owing to the escape of carbonate and hydrosulphuric acids) takes place, and a portion is dissolved, but the greater part remains undissolved. In one sample Dr. Brett[1] found from 78 to 87·5 per cent. of *sulphate of baryta*. The remainder of the powder consisted of *oxide of iron*, *carbonate of lime*, *lead* [*sulphuret of?*], and mere *traces of zinc*.

Recently, Mr. Moore[2] has submitted specimens of commercial calamine, obtained from respectable drug houses in London, to analysis in the laboratory of the Pharmaceutical Society. The results are subjoined:—

---

[1] *Lond. Med. Gaz.* xx. 72.

[2] *Pharmaceutical Journal*, vol. viii. p. 70, 1848.

	1.
Carbonate Lime Peroxide Iron . Sulphate Baryta Water	3·6 5·2 89·3 1·9
	100·0

The results of
factitious articles.
stituted accidentally
electric calamine (s
in the Derbyshire le
addition of hydroch

Almost entirely solu
carbonic acid. When
first thrown down is re
[The above statemen
sample having these c
wisely rejected calamin

Physiological
its action to the oxi
Uses.—Calamine
a mild desiccant and

1. ZINCI CARBON
Crystallised Carbona
water, six pints :—
solution of chloride
be evolved. Collect
distilled water until
solution of nitrate o
blotting-paper place

2. CALAMINA PR
naris præparatus.
made into a very fine
be prepared, *L.*)—
offered. The *Edin*
calamine.

3. CERATUM CAL
Ceratum Epuloticu
oil with the melted
begin to solidify a
cooled, *L.* The *E*
and Simple Cerate,
application (when pre
and superficial ulcera

4. CERATUM ZINCI CARBONATIS, U.S.—This ointment has been properly introduced into the Pharmacopœia of the United States, as a substitute for the impure Calamine cerate of the British Pharmacopœias. (Precipitated carbonate of zinc, ʒij.; simple ointment, ʒx.: mix them.) It is employed for the cure of the same affections as the Ceratum Calamine.

[From the chemical composition of commercial calamine it is clear that the efficacy of this composition must have depended for many years upon the sulphate of baryta and chalk, and not upon carbonate of zinc! The Dublin College has very properly excluded such an uncertain preparation from its Pharmacopœia.—ED.]

119. ZINCI SULPHAS.—SULPHATE OF ZINC.

Formula ZnO,SO^3. *Equivalent Weight* 80·5.

HISTORY.—This salt is said by Schwartze[1] to have been known towards the end of the 13th, or at the commencement of the 14th century; but Beckmann affirms it was not known before the middle of the 16th century.[2] It has had various names; as ***sal vitrioli, white vitriol, white copperas***, and ***gilla Theophrasti***.

NATURAL HISTORY.—It occurs native at Rammelsberg, near Goslar, in the Hartz; at Holywell, in Flintshire; and other places.

PREPARATION.—It is readily prepared by dissolving zinc in diluted sulphuric acid.

The *London College* has placed the sulphate of zinc in the Materia Medica. No process is given.

The *Edinburgh College* observes that this salt may be prepared either by dissolving fragments of zinc in diluted sulphuric acid till a neutral liquid be obtained, filtering the solution, and concentrating sufficiently for it to crystallise on cooling,—or by repeatedly dissolving and crystallising the impure sulphate of zinc of commerce, until the product, when dissolved in water, does not yield a black precipitate with tincture of galls, and corresponds with the characters laid down for sulphate of zinc in the List of the Materia Medica.

The *Dublin College* gives the following directions:—Take of Zinc, laminated, or in small fragments, ℥iv.; Oil of Vitriol of commerce, f℥iij.; Distilled Water, Oij.; Nitric Acid of commerce; Dilute Sulphuric Acid, of each, f℥j; Prepared Chalk, ʒij. Place the zinc, oil of vitriol, and a pint of the water, in a porcelain capsule, and, when gas ceases to be developed, boil for ten minutes. Pass then the solution through a calico filter, and, having added to it the nitric acid, evaporate to dryness. Let the dry salt be dissolved in the remainder of the water, and let the solution when cold be shaken several times for six hours in a bottle with the chalk, and then cleared by passing it through a filter. It is now, after having been acidulated with the dilute sulphuric acid, to be evaporated till a pellicle begins to form on the surface, and then set to crystallise. The crystals thus obtained should be dried on blotting-paper without heat, and then preserved in a bottle. By further concentrating the solution from which the crystals have been separated, an additional product will be obtained.

In this process one equivalent of water is decomposed; an equivalent of hydrogen escapes, while an equivalent of oxygen unites with one equivalent of zinc to form one equivalent of the oxide which, with one equivalent of

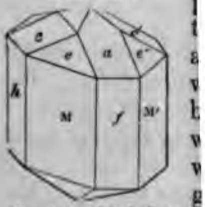
---

[1] *Pharm. Tabell.* 2te Aufl. 799.

[2] *History of Inventions*, iii. 85.

sulphuric acid, f
ZnO,SO^3+H).
The impurities
p. 762). If a pie
the liquid heated i
[Oxide of iron is
zinc be merely ke
By roasting ble
sulphate is obtain
evaporation, so th
sugar. This is di
(*vitriolum album*
phate. This impu

FIG. 138.



Crystal of Sulphate of Zinc.

l
t
a
v
b
v
v
g
b
h

Characteristics.
chloride of barium
sulphate which is in
precipitate. The p
tests already mentio
COMPOSITION.—T

Oxide of Zinc ....
Sulphuric Acid .....
Water.................

Crystallised Sulph

PURITY.—Ammo
white precipitate so
or magnesia be pr
would form an azu
cadmium may be de
of the sulphate, and
the arsenic and cad
impure sulphate call
stained yellow with t

Totally dissolved by w
ammonia is added in ex
of chloride of barium or
the sulphate dissolved in
submitted to a strong he
[On this, one observat

in nitric acid: hence the solubility or insolubility of the precipitate would depend on the relative strength of the solutions.—ED.]

When a solution in six waters is boiled with a little nitric acid, and solution of ammonia is then added till the oxide of zinc first thrown down is all redissolved, no yellow precipitate remains, or a trace only, and the solution is colourless.—*Ph. Ed.*

PHYSIOLOGICAL EFFECTS.—In *small and repeated doses* it acts as an astringent on the alimentary canal, checks secretion, and promotes a constipated condition of the bowels. It exercises a specific influence over the nervous system, manifested by its power of removing certain spasmodic affections: hence it is reputed antispasmodic. To the same influence is to be referred its power of preventing the recurrence of intermittent maladies, from which it has principally derived its denomination of a tonic. Its astringent effect is not confined to the bowels, but is manifested on the pulmonary and urethral mucous membranes, the secretions from which it diminishes; hence the advantage of its use in catarrhal affections of these parts. It does not appear to possess any power of checking cutaneous exhalation.

In *full medicinal doses* it is a powerful but safe emetic; it excites speedy vomiting without giving rise to the same degree of distressing nausea occasioned by emetic tartar. Dr. Cullen[1] observes, that "in order to render its effects certain, the dose must generally be large; and if this is not thrown out again immediately it is apt to continue a disagreeable nausea, or even a vomiting, longer than is necessary." In *excessive doses* it acts as an irritant poison, causing vomiting, purging, coldness of the extremities, and fluttering pulse.

The *local action* of it is that of an astringent and desiccant, and in a concentrated form, it is a powerful irritant and caustic. Its external use is said to have been found fatal in one case, by causing vomiting, purging, and convulsions.[2] Its causticity depends on its affinity for albumen and fibrin.

USES.—As an *emetic* it is almost exclusively employed in poisoning, especially by narcotics. In these cases it is the best evacuant we can administer, on account of its prompt action. As an *internal astringent* it is administered in chronic dysentery[3] and diarrhœa, in chronic bronchial affections attended with profuse secretion, and in gleet and leucorrhœa. In the latter cases it is usually associated with terebinthinate medicines, and is sometimes decidedly beneficial.[4] As an *antispasmodic* it has been employed with occasional success in epilepsy, chorea, hysteria, spasmodic asthma, and hooping-cough. I have little faith in its efficacy in any of these cases. It has been spoken favourably of by Dr. Babington[5] in the treatment of epilepsy. He has sometimes given as much as thirty-six grains three times a day. As a *tonic*, it has been serviceable in agues, but it is far inferior to sulphate of quina or arsenious acid.

As a *topical astringent* sulphate of zinc is most extensively employed. We use its aqueous solution as a collyrium in chronic ophthalmia, as a wash for ulcers attended with profuse discharge, or with loose flabby granulations;

---

[1] *Treat. of the Mat. Med.*

[2] Christison, *op. cit.* p. 468.

[3] Impey, *Lond. Med. and Phys. Journ.* ix. 53, 1803.

[4] See a paper on this subject, by Mr. Graham, in the *Edinb. Med. and Surg. Journ.* vol. xxvi.

[5] *Guy's Hospital Reports*, No. xii. 1841.

as a gargle in ulc
purpose much in
chronic skin disea
ADMINISTRATIO
grains; as a *tonic*
For external us
the sulphate to a
knew employed c
water: it was use
this strength must
ANTIDOTES.—P
wards allay hypere
regimen. Vegetal

120. ZINC

HISTORY.—This
first introduced in
recommended by
Paris.[3] It is term
PREPARATION.—
solving zinc, or its
fusing in a glass v
tion it is obtained
metals, as of pallad
[Another process
sulphate of zinc by
or of barium be em
at once from the pr
be used, the chlori
way. Ores of zinc
and chloride of zinc
and the chloride of
is also obtained.[4]—

The *London College* c
broken into small piece
and when the effervesce
evolved. Pour off the
residue in a tightly cov
Lastly, when cold, brea
The *Dublin College* d
Evaporate it down in a
cool, it solidifies. Sub
well-stopped bottle.

PROPERTIES.—It
ness of wax. It is s

---

[1] *Russ. Samml. f. Natur*
[2] Rust's *Magazin*, 1826
[3] Dr. Alex. Ure, *Lond.*
[4] *Pharmaceutical Journ*

at a strong heat, may be sublimed and crystallized in needles. It is very deliquescent. It unites with both albumen and gelatine to form difficultly soluble compounds, and hence it occasions precipitates with liquids containing these principles in solution. A patent has been obtained by Sir William Burnett for the preservation of wood, and other vegetable matters, by impregnating them with a solution of chloride of zinc.

Characteristics.—Dissolved in water it may be recognised to be a chloride by nitrate of silver. That zinc is the base of the salt may be shewn by the tests already mentioned for the salts of this metal.

Free from colour: it deliquesces in the air, is soluble in water and rectified spirit. Hydrosulphuric acid or ferrocyanide of potassium throws down a white precipitate from the watery solution. What is thrown down from the solution by ammonia or potash is white, and when either alkali is added in excess this precipitate is redissolved. Moreover, what is precipitated by the addition either of carbonate of potash or ammonia is white, but it is not redissolved by an excess."—*Ph. Lond.*

[On this we may remark, that the statement "non autem liquatur iisdem supra modum additis," so far as relates to the carbonate of ammonia, is incorrect. The carbonate of zinc thrown down from the chloride is perfectly soluble in an excess of carbonate of ammonia. If any of the white precipitate remains undissolved, this might indicate the presence of lead or cadmium as an impurity in the zinc.—ED]

COMPOSITION.—Its composition is as follows:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*J. Davy.*
Zinc	1	32·5	47·8	50
Chlorine	1	35·5	52·2	50
Nitrate of Baryta	1	68·0	100·0	100

PHYSIOLOGICAL EFFECTS.—Its *local* action on living tissues is, when in a concentrated solution, that of a caustic or escharotic, depending partly on its affinity for albumen and gelatine; so that when placed in contact with living parts into whose composition these organic compounds enter, the chloride exercising its affinity, destroys the life of the part, and unites with the albuminous and gelatinous matters present, and forms thus an eschar. Other chemical changes of a comparatively unimportant nature are also effected: thus, various salts found in the solids or liquids of the parts may be decomposed. For example, when the chloride is applied to a cancerous sore, it decomposes the carbonate and hydrosulphuret of ammonia found in the secretion of the sore. The effects produced by the application of chloride of zinc are the following:—Soon after it has been applied a sensation of warmth is felt in the part, quickly followed by a violent burning pain, which continues for seven or eight hours; that is, until the parts in contact with the chloride are dead. A white eschar is now observed, which usually separates in from eight to twelve days. Unless used in the neighbourhood of loose cellular tissue, there is rarely much swelling. As a caustic, chloride of zinc is not inferior in power to chloride of antimony: nay, Vogt[1] says it appears to him to be more powerful and to penetrate deeper. It decomposes the organic tissues as quickly as nitrate of silver, but excites more burning, and for a longer time, owing to its action extending to parts placed more deeply, for it is well known that the operation of the nitrate is confined to superficial parts. To this circumstance is owing, in great part, the efficacy of the chloride in various diseases in which it has been applied, and the healthy appearance of the sore after the separation of the eschar. There is no danger of any

---

[1] *Pharmakodynamik*, i. 363, 2te Aufl.

to us by Mr. Allan
are well calculated
acute case of poiso

A woman, æt. 28, s
had been sold to her a
Allanson: she was lyi
flushed, the eyes turn
and feet were cold, an
complained of a burnir
mouth, the tongue was
riation. It had been
but there was no ind
after she had taken th
the most prominent sy
rational, and could spe
spected fifty-three hou
the abdomen, the stom
and prominent. The u
the same pale hue. Th
removing the stomach,
milk which had been a
thin tripe; they were n
taken had passed thro
covered the whole muc
lium, white and easily d
were perfectly healthy.
mach to us about three
very high, and the circ
trace of this process.
sistency of tripe, and of
On cutting the stomach
in the filtered liquid.—E

Taken in *very smal*
times the ameliorati
influence the nervous

Uses.—*Internall*
increased doses in scr
cyanic acid) in neural
employed *externally*
in fistulous ulcers of
by Professor Hancke
materni, and as an ap

ADMINISTRATION.—*Internally*, it may be given in doses of one or two grains. Hufeland recommends it to be taken dissolved in ether: his formula for the *æther zinci*, as it is called, is the following:—℞ Zinci Chlor. ℨss.; Alcoholis, ℥j.; Ætheris Sulph. ℥ij.; Post aliquot dies decanta. The dose of this solution is from four to eight drops taken twice daily.

Externally it has been used as a *lotion*, composed of two grains of the chloride and an ounce of water; or in the form of *paste*: this may be composed of one part of chloride of zinc, and from two to four parts of either wheaten flour, or plaster of Paris (sulphate of lime).[1]

ZINCI CHLORIDI LIQUOR; *Solution of Chloride of Zinc*, D. (Take of Sheet Zinc, lb. j.; Muriatic Acid of Commerce, and Water, of each, Oiiss., or as much as may be sufficient; Solution of Chlorinated Lime, f℥j.; Prepared Chalk, ℥j. To the zinc, introduced into a porcelain capsule, gradually add the muriatic acid, applying heat until the metal is dissolved. Filter the liquid through calico, and, having added to it the solution of chlorinated lime, concentrate at a boiling temperature, until it occupies the bulk of one pint. Permit the solution now to cool down to the temperature of the air, place it in a bottle with the chalk, and, having first added distilled water, so that the bulk of the whole may be a quart, shake the mixture occasionally for twenty-four hours. Finally, filter, and preserve the product in a well-stoppered bottle. The specific gravity of this liquor is 15·93.)

Sir W. Burnett's Disinfecting and Antiseptic Fluid is a strong solution of chloride of zinc. The solution sold for this purpose has a sp. gr. of 2·0, and contains 25 grains of zinc in every fluidrachm. In using it, one pint is mixed with five gallons of water.[2] Its action as an antiseptic and preservative depends on its combination with the dead animal tissues. Injected into the blood-vessels, it has been successfully employed to preserve anatomical subjects for dissection. It is said to have no injurious action on knives or other steel instruments; but the accuracy of this observation is doubtful. As a disinfectant and deodorizer, its action depends principally on its power of decomposing hydrosulphuret of ammonia. Its power of decomposing sulphuretted hydrogen is very limited, [since an acid solution of zinc is not decomposed by sulphuretted hydrogen, and the deodorizing action cannot take place without hydrochloric acid being set free.—ED.] Unlike chloride of lime, it does not give out any disinfecting vapour.

[Another solution, similar to that of Burnett's, is now sold under the absurd name of Crew's *Disinfecting* liquid, when in fact, like that of Sir W. Burnett, it is merely *deodorizing*. Mr. Way has analysed the two liquids and gives as the mean results of his analyses—

	Burnett.	*Crew.*
Density	1·616	1·616
Per Centage of Chloride of Zinc	53·62	53·78

This proves that the two liquids are of similar composition and as nearly as possible of equal strength. Burnett's fluid generally contains chloride of iron.

---

[1] [The late Mr. Liston was in the habit of using this mixture as a cautery in foul ulcers and cancerous tumors. It is prepared by Mr. Squire, of Oxford Street, in the convenient form of sticks.—ED.]

[2] *Pharmaceutical Journal*, vol. vii. pp. 60 and 107, 1847.

The author has abov
and a solution of chl
zinc-preparations, th
in them, and their d
beyond which chlorid
in inhabited dwellin
objectionable. On t
which reach it, but
the air, and thus me

121. ZIN

Formula

History.—This s

Preparation.—I
acid, and crystallisin
be readily obtained
sulphate of zinc, diss
acetate of lead in
which, being insolu
acetate of zinc are le
Or it may be procur
of lead, until the liq
In this process the l
saturni, or *lead tre*

The *Dublin Pharmaco*
of Lead, lb. j.; Sheet Z
a sufficient quantity. I
solution in a cylindric ja
twenty-four hours deca
ounces, drop into it, wh
tate ceases to form. It
by the addition of a few
when, upon cooling, crys
the concentration of the
porous brick, and then w

Properties.—It u
or silky lustre closely
rhombic prism. The
dissolves readily in wa

Characteristics.—
vapour, having the od
the salt, and heat is a
recognised by its odou
it is a zincic salt is pr

Composition.—Its
Dr. Thomson, $ZnO,\bar{A}$,

Physiological Eff
of zinc. Its local acti

acts as a tonic and antispasmodic; large doses occasion vomiting and purging. Devaux and Dejaer[1] deny that it is a poison, even in large doses.

USES.—It is rarely administered *internally;* but is applicable as an emetic, tonic, and antispasmodic, in the same cases in which the oxide or sulphate of zinc is employed. As a *topical* remedy, it is used, on account of its astringent qualities, in chronic ophthalmia, gleet, and leucorrhœa. In the latter stages of gonorrhœa I have found it far more successful than the sulphate. Its beneficial effects were first described by the late Dr. William Henry, of Manchester.[2] Sir A. Cooper[3] recommmends, as the best injection which can be used in the third week of gonorrhœa, a mixture of six grains of sulphate of zinc and four ounces of liquor plumbi subacetatis dilutus. Of course double decomposition takes place, and the active ingredient is the acetate of zinc.

ADMINISTRATION.—When exhibited internally, as a tonic or antispasmodic, the dose is one or two grains gradually increased. As an emetic it is rarely administered: the dose is from ten grains to a scruple: its operation is very safe. As a lotion or injection, it is employed in the form of aqueous solution containing two or more grains of the salt to an ounce of water.

122. Zinci Valerianas.—Valerianate of Zinc.

The *Dublin* Pharmacopœia contains the subjoined formula for this preparation:—

Take of Valerianate of Soda, ℥iiss.; Sulphate of Zinc, ℥ij. and ʒvii.; Distilled Water, Oij. Dissolve the valerianate of soda in one half, and the sulphate of zinc in the remaining half of the water; and having raised both solutions to 200°, mix them, and skim off the crystals which are produced. Let the solution be now evaporated at a temperature not exceeding 200°, until it is reduced to the bulk of four ounces, removing, as before, the crystals from the surface, in proportion as they form, and placing them with those already obtained The salt thus produced is to be steeped for an hour in as much cold distilled water as is just sufficient to cover it, and then dried at a heat not exceeding 100°.

123. Zinci Cyanidum.—Hydrocyanate, Cyanide, or Cyanuret of Zinc.

Formula ZnCy. *Equivalent Weight* 58·5.

This salt was introduced, by the German physicians, as a substitute for hydrocyanic acid. It is prepared by adding recently-made oxide of zinc to hydrocyanic acid; or by adding a solution of sulphate of zinc to a solution of cyanide of potassium. It is a white powder, insoluble in water or alcohol. If a strong mineral acid be added to it, hydrocyanic acid is developed, and a soluble salt of zinc obtained. The latter is recognised by the tests before mentioned for a solution of zinc. It consists of one equivalent or 32 parts of *Zinc*, and one equivalent or 26 parts of *Cyanogen*.

Its effects have not been carefully ascertained, but they are supposed to be similar to those of hydrocyanic acid. It has been used principally in affections of the nervous system; as epilepsy, hysteria, and chorea. It has also been employed in cardialgia and cramps of the stomach, and as an anthelmintic in children. The dose is a quarter of a grain to a grain and a half three times a day. It may be taken in the form of powder mixed with calcined magnesia.

---

[1] Orfila, *Toxicol. Gén.*

[2] *Lond. Med. and Phys. Journ.* ix. 53, 1803.

[3] *Lancet*, iii. 199.

ORDER XXI

The metal *Cadmium*,
about the same time, bo
καδμεία, or *καδμία*, an an
phuretted hydrogen (H
yellow precipitate, CdS,
has been used in medicin
resemble those of the zi

125. Ca

F

Cadmium Sulphuricum
by dissolving carbonate o
the neutral liquid so that
parts of cadmium in a mi
the addition of some
The solution is to be ev
solution filtered, and evap
formed. These are right
and effloresce in the air.
readily soluble in water:

PROPERTIES.—Sulphate
of zinc. Its action on
barth:[2] the former states
found that in doses of 20
injurious effects. Burdac
ing, and pain, from half a
M. Grimaud[3] to possess as
M. Grimaud asserts that
the power of causing pust

The topical effects of th
cadmium has been almost
cases in which sulphate of
it has been successfully em
others. In chronic ophtha
applied a solution of it as

As a topical remedy, it
solution of from gr. ss. to
application to the eye; an
otorrhœa. As an eye oint

---

[1] *Diss. sistens experim. qu*
1819.

[2] Hufeland's *Journal*, Jan.

[3] *Ibid.* Jan. 1827, S. 129.

[4] *Medical Times*, vol. xxiii.

[5] Gräfe u. Walther's *Journa*

[6] *Bibl. Ophthalmologique.*

[7] *Clinique Chirurgicale*, Li

[8] *Denkwürdigkeiten*, Bd. i.

[9] Dierbach, *Die neuesten E*

[10] Aschenbrenner, *Die neuer*

ORDER XXV. TIN AND ITS COMPOUNDS.

126. STANNUM.—TIN.

Symbol Sn. *Equivalent Weight* 59.

HISTORY.—Tin has been known from the most remote periods of antiquity. It is mentioned by Moses[1] and by Homer.[2] The alchymists called it *Jove*, or *Jupiter*, ♃.

NATURAL HISTORY.—It is peculiar to the mineral kingdom. It occurs in two states; as an oxide, SnO^2 (the *tin stone* and *wood tin* of mineralogists), and as a sulphuret (*tin pyrites*, $2FeS,SnS^2 + 2Cu^2S,SnS$). It is found in both states in Cornwall, which has long been celebrated for its tin works. The Phœnicians, who were perhaps the first people who carried on commerce by sea, traded with England and Spain for tin at least 1000 years before Christ. Oxide of tin in very small quantities has been found in Saidschütz water, and in many meteoric stones (L. Gmelin).

PREPARATION.—In Cornwall, *stream tin* (a variety of *tin stone*) is smelted with charcoal or with culm in a reverberatory furnace. The metal thus procured is subsequently made hot, and then let fall from a height, or is struck with a hammer, by which it splits into a number of irregular prisms, somewhat like a basalt pillar. This is called *grain tin*: of this there are two kinds, the *best*, which is used for dyers,—and a second employed in the manufacture of tin plate, and which is called *tin-plate grain*. *Mine tin* (another variety of *tin stone*) is stamped, washed, roasted, afterwards smelted with Welsh culm and limestone, by which *block tin* is procured, the finest kind of which is called *refined tin*.[3] Besides the two varieties of tin just described, other kinds are met with in commerce. *Malacca tin* occurs in quadrangular pyramids, with flattened bases. *Banca tin* is met with in wedge-shaped pieces.

PROPERTIES.—In its massive form it is a yellowish-white metal, having a peculiar odour when rubbed or handled, and crackling when bent. Its sp. gr. varies from 7·178 to 7·299. It melts at 442° F., and at a white heat is volatilized. It is malleable, and forms *sheet tin* and *tin foil* (*stannum foliatum*), but is sparingly ductile.

Characteristics.—Boiled in strong hydrochloric acid, we obtain a solution of protochloride of tin (SnCl), which has the following characters:—Potash added to it causes a white precipitate (SnO,HO) soluble in excess of the precipitant; hydrosulphuric acid produces a brown precipitate (SnS); and terchloride of gold, a dark purplish precipitate, called *the purple of Cassius*, and composed of $2(SnO,SnO^2) + AuO^3,SnO_2 + 6HO$. A small quantity of protochloride of tin added to a solution of corrosive sublimate causes a white precipitate of calomel: a large quantity reduces the mercury to the metallic state. If protochloride of tin be heated with nitric acid, we obtain the bichloride ($SnCl^2$), which causes a yellowish precipitate (SnS^2) with hydrosulphuric acid.

---

[1] *Numbers*, xxxi. 22.

[2] *Iliad*, xi. 25.

[3] Mr. John Taylor, *Ann. Phil.* iii. 449.

PHYSIOLOGICAL E
except that arising f
produce any disord
that acid, fatty, salin
and vomiting by ha
tin is poisonous, acc
USES.—Tin foil i
taining pommades a
late, and other subst

STANNI PULVIS, I
be prepared in variou

The *Edinburgh Colleg*
an iron vessel; pour it i
of the metal; triturate
is pulverised; sift the p
The *Dublin College* or
lead crucible, and, while
powder. Let the finer
been several times in su
quite clear, let the prod

Tin may be reduce
box, the inside of whi

When finely granulate
fluidrachms of nitric ac
filtered, is colourless, an
of magnesia.—*Ph. Edinb*

The sulphate of m
lead in solution, with
Powdered tin has b
as a vermifuge, partic
on mechanical princip
worms and the inner c
hold, so that the purg
however, been asserte
tic, at least so say Pit
tin vessel is also state
the before-mentioned n
fore supposed that the
the alimentary canal;
found in tin, is the act
metal, by its action on
sulphuric acid, which d
pounds of tin operate
yields some compound
Dr. D. Monro, Fotherg

---

[1] *To*
[2] Q
[3] *M*
[4] Q

produced by worms, and, as it is stated, with advantage. It is commonly employed in doses of one or two drachms. Alston's mode of employing it as a vermifuge was the following:—The patient was well purged with senna, and on the following morning *one ounce* of tin powder was given in four ounces of treacle: on each of the two following days half this quantity was taken, and then the patient again purged. *Tin filings* (*stanni limatura* seu *rasura stanni*) have also been used in medicine.

127. Stanni Bisulphuretum.—Bisulphuret of Tin.

Formula SnS^2. *Equivalent Weight* 91.

Aurum Musivum, or *Mosaic Gold*. Obtained by subjecting to heat a mixture of tin, mercury, sal ammoniac, and sulphur. The mercury facilitates the fusion of the tin and its combination with sulphur; the sal ammoniac keeps down the temperature, and thereby prevents the conversion of the bisulphuret into protosulphuret of tin.—It has a beautiful golden lustre, a flaky texture, and a greasy or soapy feel. In the arts it is used as a *bronze powder*, especially for the manufacture of paper-hangings. In medicine it has been used as an anthelmintic for tænia; in doses of from ʒij. to ʒiv., mixed with honey, as an electuary.

128. Stanni Chloridum.—Chloride of Tin.

Formula $SnCl$. *Equivalent Weight* 94·5.

Protochloride of Tin; Protomuriate of Tin; Stannum Muriaticum Oxydulatum; Salt of Tin. Obtained by dissolving granulated tin in boiling hydrochloric acid, and evaporating the solution so that it may crystallise. The crystals (the *hydrated chloride of tin*, $SnCl,HO$) are colourless and transparent; by the aid of water they are decomposed into the hydrochlorate of the chloride, which remains in solution, and a white pulverulent oxichloride ($SnCl,SnO$), which precipitates: an excess of hydrochloric acid prevents this decomposition. The chemical characteristics of chloride of tin have been already stated. Chloride of tin acts topically as an astringent, irritant, and caustic. After its absorption, it acts, like the antimonials, powerfully on the skin. When taken as a poison, it causes convulsive movements of the muscles of the extremities and of the face, and sometimes paralysis. It has been used as a vermifuge against tapeworm; as an antispasmodic in epilepsy, chorea, and other convulsive diseases; as a stimulant to paralysed muscles in paraplegia; as an antidote in poisoning by corrosive sublimate; and as an external application in chronic cutaneous diseases. Internally, it is administered in doses of from $\frac{1}{16}$th of a grain to half a grain twice or thrice a day, taken either in spirit of hydrochloric ether or in the form of pills. Externally, it has been used in the form of aqueous solution prepared by dissolving from $\frac{1}{4}$th of a grain to 1 grain in an ounce of distilled water. In case of poisoning by the chlorides of tin, milk and other albuminous substances should be administered. [This compound, under the name of *Stanni Protochloridum*, is entered as a test in the Appendix to the London Pharmacopœia; but there is no formula for its preparation.—ED.]

ORDER XXVI. LEAD AND ITS COMPOUNDS.

129. PLUMBUM.—LEAD.

Symbol Pb. *Equivalent Weight* 104.

HISTORY.—This metal was known in the most remote ages of antiquity. It is mentioned by Moses.[1] The Greeks called it μόλυβδος; the alchymists, *saturn*, ♄.

---

[1] *Job*, xix. 23, 24; *Exodus*, xv. 10.

NATURAL HISTORY.—It is found both in the metallic state (*native l*
and mineralized. It is met with combined with sulphur (*galena*).
selenium, with chlorine (*horn lead*), with oxygen (*native minium*), an
oxygen and an acid, forming an oxy-salt (*carbonate, phosphate, sul*
tungstate, molybdate, chromate, arseniate, and *aluminate*).

PREPARATION.—It is usually extracted from galena (PbS), which is r
in reverberatory furnaces, by which it loses the greater part of its sulp
sulphurous acid, SO^2, and is converted into a mixture of lead, oxide o
sulphate of lead, and some undecomposed sulphuret of lead, and after
smelted with coal and lime; the first to abstract oxygen, the sec
remove the sulphur. Oxide of lead readily decomposes sulphuret o
under the influence of heat, and produces sulphurous acid and metallic
$PbS + 2PbO = 3Pb + SO^2$. Sulphuret of lead, and sulphate of lead also a
heat, yield metallic lead and sulphurous acid. $PbS + PbO,SO^3 = 2Pb +$

PROPERTIES.—It has a bluish-gray colour and considerable brilliancy
may be crystallised, by cooling, in four-sided pyramids. It is malleabl
very imperfectly ductile. Its sp. gr. is 11·35. It has a peculiar odour
handled [and is known from tin by its producing a black discolouratio
the fingers when rubbed]. It fuses at 612° F., and at a red heat boil
evaporates. By exposure to the air it attracts, first oxygen, and then
bonic acid.

Pure distilled water has no action on lead,[1] provided the gases (as a
carbonic acid) be excluded; but if these be admitted, a thin crust of
hydrocarbonate of lead is soon formed.[2] It is remarkable that the pre
of most neutral salts, especially carbonates and sulphates, impairs the
sive action of air and water, and, therefore, exerts a protective influ
The chlorides (muriates) are the least protective. Hence, therefore, we
easily understand why leaden cisterns and pipes do not more frequently
a metallic impregnation to water; and why very pure well-water or
water is more apt than common well-water to become impregnated with
(see *ante*, p. 291).

The water of Ascot Heath is deficient in those salts which exert a protective inf
on water, and, therefore, readily acquires a plumbeous impregnation[3] from the
through which it passes. The dogs of the Royal kennel suffered with saturnine pa
(called *kennel lameness*) from this circumstance, and various persons also mani
symptoms of lead poisoning from the same cause.[5]

Characteristics.—If lead be dissolved in nitric acid, and the exce
acid expelled by heat, we may easily recognise its presence in the sol
(PbO,NO^5) by the following tests:—Sulphuretted hydrogen and fresh
pared hydrosulphuret of ammonia[6] occasion a black precipitate (P

---

[1] For some observations on this subject, see Dr. Taylor's memoir in the *Guy's Hospital R*
vol. iii.

[2] Christison, *Transactions of the Royal Society of Edinburgh*, vol. xv. part ii. 1842.

[3] Squire, *Pharm. Journ.* vol. iv. p. 9, July 1844; Dr. Ryan, *Lond. Med. Gaz.* Aug. 1845, p

[4] *Times*, Jan. 9, 1842; *Sunday Times*, March 26, 1843.

[5] Pearl, *Lond. Med. Gaz.* Aug. 1, 1845, p. 598.

[6] Hydrosulphuret of ammonia which has been exposed to the air for some time yields a re
cipitate (*polysulphuret of lead?*) in a solution of lead.—"If a solution of nitrate of le
precipitated with hydrochloric acid, and the filtered solution treated with hydrosulphuric acid (
instead of the black sulphide usually formed by that reagent in solutions of lead, there is pr
a red precipitate, which is chloro-sulphide ($3PbS,2PbCl$)." (J. E. Bowman, *Introducti*
Practical Chemistry, pp. 101 and 102, 1848.)

ammonia and potash cause a white precipitate (PbO, with some subnitrate); carbonate of potash and of soda produce a white precipitate (PbO,CO^2); sulphuric acid and the sulphates, a white precipitate (PbO,SO^3); ferrocyanide of potassium, a white precipitate ($Pb^2,FeCy^3$); chromate of potash, yellow (PbO,CrO^3); and iodide of potassium, yellow (PbI). A piece of zinc plunged into the solution throws down metallic lead in an arborescent crystalline form.

PHYSIOLOGICAL EFFECTS. **1. Of Metallic Lead.**—Metallic lead is probably inert. Three ounces and six drachms have been administered to a dog without any obvious effects.[1] As, however, it readily becomes oxidated, it occasionally acquires activity. Paulini[2] says colic was produced by a leaden bullet having been swallowed. Proust[3] states that an alloy of tin and lead is less easily oxidated than pure lead.

2. Of the Preparation of Lead. α. *On Vegetables.*—See *Plumbi Acetas.*

β. *On Animals.*—The effects on animals are similar to those on man.

γ. *On Man.*—With few exceptions all the compounds of lead are poisonous. Orfila[4] gave an ounce of the *sulphuret* to dogs with impunity; and four ounces have been given to horses without ill effects. Mr. Braid[5] says that the workmen who dig and pulverise the sulphuret at the Lead Hills in Lanarkshire never have lead colic until they work at the smelting furnaces. The *sulphate* has also been said to be inert; but there is doubt about this (see p. 190). All the other preparations of lead are more or less active. The general effects of lead have been described in a previous part of this work (see *ante*, p. 191). The preparations of this metal act chemically on the animal tissues and fluids. They are usually described as possessing astringent and sedative qualities. By long-continued use they impoverish the blood and give rise to paralysis.

1. *General or primary effects of lead.*—These constitute what Tanquerel des Planches calls *primitive saturnine intoxication.* Under this head are included—1st, the sedative and astringent effects of lead; 2ndly, the leaden discolouration of the gums, buccal mucous membrane, and the teeth; 3rdly, the lead taste and breath; 4thly, lead jaundice; 5thly, lead emaciation (*tabes saturnina* vel *sicca*). These effects have been before noticed (see *ante*, p. 190). To the account already given it will only be necessary to add a few observations on the primary effects of small and large doses of lead.

In *small doses* the preparations of lead act on the alimentary canal as astringents, checking secretion and causing constipation. After absorption, the constitutional effects of lead are observed: the arteries become reduced in size and activity, for the pulse becomes smaller and frequently slower also, the temperature of the body is diminished, and sanguineous discharges, whether natural or artificial, are frequently checked, or even completely stopped. This constringing and sedative effect seems extended to the secreting and exhaling vessels, the discharges from the mucous membranes, the exhalation from the skin, and the urine, being diminished in quantity. Thus we observe dryness of the mouth and throat, thirst, greater solidity of the alvine evacua-

---

[1] *Journ. de Méd. de Leroux*, xxiii. 318.

[2] *Miscell. Nat. Cur. Dec.* ii. Ann. vi. App. p. 7, quoted by Voigtels, *Arzneimittellehre.*

[3] *Ann. de Chim.* lvii. 84.

[4] *Toxicol. Gén.*

[5] Christison, *op. cit.* 518.

tions, diminution of
Besides the leaden
mouth, and teeth, ca
allied effects have bee
a bluish colour of the
Dr. Burton, "that sa
by the internal operati
and not characteristi

In *very large dos*
example) act as irrit
toms indicative of ga

2. *Special diseas*
and brain disease, or,
are not of equally f
Tanquerel des Planc

Colic .
Arthra
Paraly
Encep

These diseases ma
bined in the same in
the first observed; b
liable to appear at th

a. *Lead or satur*
pains, attended by e
pressure, accompanie
abdomen, obstinate c
gas through the mou
agitation, anxiety, an
tractility and secreti
examining the bodies
a contracted conditio
Copland,[6] have not, i
appear probable from
and collapsed portion
part found in a state
natural condition of
is, in ordinary cases
arising from a paraly
to contract and prop
more probable, since
is doubtless of the sa

---

[1] Dr. Warren, *Medical T*
[3] Dr. A. Thomson, *Elem*
N. S. vi. 292.
[3] *Traité des Maladies de*
[3] Tanquerel des Planche
eases, Lowell, 1848.
[4] *Path. Anat.* by Townse
[5] *Dict. Pract. Med.* i. 36
[6] *On Diseases of the Abd*

In conclusion, we may affirm with Tanquerel des Planches that there are no anatomical alterations perceptible to the senses which produce all the pathological phenomena of lead colic, and that the material alterations that may be found are only effects, and not causes, of the symptoms observed during life.

The writer just quoted considers lead colic to be neuralgia of the digestive and urinary organs, produced by the introduction and absorption of lead in a molecular state into the system. Lead colic is accompanied by the blue line on the gums above referred to, which, therefore, is an important aid in distinguishing this variety of colic from that which arises from other causes. [Preparations of mercury may produce a discolouration of the gums simulating that produced by lead.—ED.]

The late Dr. Anthony Todd Thomson[1] held the opinion that carbonate of lead was the only preparation of this metal that could produce colic; but though he has, I think clearly, shown that lead colic more frequently arises from the carbonate than from any other salt of lead, he has, in my opinion, failed in proving that no other preparation of lead *can* produce it. Indeed, if his opinion were true, it would constitute an exception to the general effects of the metallic preparations; for we do not find that the specific effects of arsenic, or of mercury, or of copper, or of antimony, are produced by one preparation only: so that, *à priori*, analogy is wholly against the opinion. Furthermore, it is well known that the vapour of the oxide of lead taken into the lungs may produce colic, and that the ingestion of the nitrate, acetate, citrate, or tartrate of lead, is capable of exciting the same effect. Dr. Thomson explained these facts by assuming that the oxide of lead united with carbonic acid in the lungs, and was thus converted into carbonate; and that the acetate, citrate, and tartrate, were decomposed in the alimentary canal, and converted into carbonates. But it appears to me to be much more simple and consistent with analogy to admit that these preparations are of themselves capable of producing colic, than to assume that they undergo the changes here supposed. Moreover, in some instances in which colic was produced, it is unlikely that these changes would have occurred, owing to the excess of acid taken with the salt of lead. [Acetate of lead given with an excess of acetic acid has produced all the effects of lead poisoning; a sufficient proof that Dr. Thomson's assumption is unfounded.—ED.]

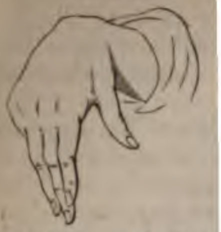
b. *Lead arthralgy*, called by Sauvages *metallic rheumatism*, is characterised by sharp pains in the limbs, unaccompanied by either redness or swelling, not precisely following the track of the nervous cords—constant, but becoming acute by paroxysms, diminished by pressure, increased by motion, and accompanied by cramps with hardness and tension of the painful parts. Lead arthralgy is most readily distinguished from other kinds of arthralgy by the discolouration of the gums which accompanies poisoning by lead. The disease appears to be a purely nervous lesion. No anatomical changes have been recognised in the affected parts, though Devergie has detected lead in the muscles of a patient who suffered with it.

c. *Lead* or *saturnine paralysis* is characterised by a loss of voluntary motion, owing to the want of contractility of the muscular fibres of the

---

[1] *Lond. Med. Gaz.* v. 538, and x. 689.

FIG. 139.



Wrist-drop and Emac
Flexors of the Thum
Lead. (M. Hall.)

while labouring unde
spinal marrow. Th
and very pale, and h

Paralysis of sensa
paralysis of motion,
out colic, or it may
general it succeeds
of paralysis by the b

d. *Disease of the*
pathy.—This malad
functions. There ar
rium, either tranquil
second or *comatose*
some cases it is acco
form, convulsions ar
partial or general,—
or cataleptiform; th
stitute, true epilepsy
we have the reunion
functional lesions ar
the conditions of the
the brain.

MODUS OPERANDI
the splenic, mesenter
also found it in the
chyle nor the urine.
cord. More recentl
urine of animals pois
tion of the soluble sa
organic constituents
of lead probably depe
whose functions are
cord, and muscles of
These parts have, the

---

[1] *Vers. über d.*
[2] Christison's *Tre*
[3] Orfila, *Traité de*

Absorption of the plumbeous preparations may be effected by the digestive organs, by the respiratory organs, by the conjunctiva, and probably also by the skin. Tanquerel des Planches endeavours to prove the impossibility of absorption by the latter; but his arguments are not conclusive, and are opposed to ordinary experience. The poisonous effects of lead may arise from the introduction of the plumbeous particles into the stomach along with articles of food and drink; or into the air-passages, in the form of dust or vapour, along with the air; or from their application to the conjunctiva, skin, or ulcers. Hence the persons most liable to these effects are those whose occupations bring them in contact with this metal; for example, painters, plumbers, roasters and smelters of lead, the manufacturers of the plumbeous preparations, glass-blowers, potters, and lapidaries. Lead is eliminated from the system by the urine, by the skin, by the milk, and probably by the bowels.

USES.—The general objects for which the preparations of lead are employed in medicine have been already pointed out (see *ante*, p. 190.) The nitrates and acetates of lead have been used as disinfectants. During their administration, attention must be paid to the condition of the gums, the stomach, and the bowels, as we find traces of their injurious effects in these organs. Especial attention should be paid to the appearance of the blue line on the gums. Constipation is a very frequent result of the medicinal employment of lead. Loss of appetite, indigestion, and griping pains, are also often noticed. The tendency to colic is diminished, according to Dr. A. T. Thomson, by conjoining acetic acid.

ANTIDOTES.—There are two classes of agents which lessen or destroy the poisonous effects of lead; these are sulphuretted hydrogen, and the soluble metallic sulphurets, on the one hand; and sulphuric acid and the soluble sulphates, on the other. The first render lead inert, by forming with the lead salts the black inert sulphuret of lead, PbS; the second do so by giving rise to the white insoluble sulphate of lead, PbO,SO^3. It may be doubted, however, whether this last mentioned compound be absolutely inert; for it is plausibly stated by Mialhe that under the influence of the alkaline chlorides (common salt, for example) contained in the animal fluids, the sulphate becomes partially or wholly converted into chloride of lead, $PbO,SO^3 + NaCl = PbCl, + NaOSO^3$, which being soluble is capable of becoming absorbed and of acting deleteriously on the system. Moreover, the alkaline acetates, as of ammonia and hydrochloric acid, dissolve sulphate of lead. The soluble metallic sulphurets, on the other hand, cannot be extensively used as antidotes, as they are themselves energetic poisons: Rayer found that their internal use was not so successful as chemical reasoning had led him to expect. The following are, I believe, the best antidotal means of counteracting lead poisoning:—

1. *Antidotal treatment of acute lead poisoning.*—Administer large quantities of diluents acidulated with sulphuric acid or holding in solution some soluble alkaline or earthy sulphate, as sulphate of soda, sulphate of magnesia, or alum. Dr. Alfred Taylor recommends a mixture of sulphate of magnesia and vinegar to be administered in poisoning by white lead (carbonate of lead). The acetic acid of the vinegar dissolves the lead, which is immediately rendered insoluble by the sulphate of magnesia. If vomiting have not already

come on, the poiso
before recommende
2. *Antidotal tr*
treatment applies to
in which patients ar
patient in the sulph
in warm water. T
salts of lead deposit
The reaction of a m
$PbO+KS=PbS+$
unites with the pot
say tersulphuret, K
of sulphur S^2, are d
of lead is to be rem
stiff flesh brush and
in the sulphuretted
proceedings should
by the sulphuretted
dered insoluble and
will be found that t
crustation, a fact w
(see *ante*, p. 191, f
action of the sulphu
every few days for s
discolouration of th
from the absorption
The internal anti
sulphuric acid (*sul*
and earthy sulphate
used with great ben
acidulated with sulp

Treacle, 15 lbs.; Br
of Soda, 1½ oz.; Oil of
add the treacle and the
the yeast. When the
with eight times its we
is fit for use in three or
the acid, forms sulphat

Instead of sulphu
the use of the sulph
tion of sulphuretted
the practical success
[Of late, iodide of
treatment of chronic
is supposed to act by
Swift,[3] U.S., states t

---

[1] Dana, *Le*
[2] *Lancet*,
[3] *Med. Tim*

York Hospital by iodide of potassium in twenty-three cases, and with very satisfactory results. In thirteen instances the urine was submitted to chemical analysis, and the investigation established the fact that the lead may be eliminated from the system by the iodide of potassium, and found in the urine. In no case was the lead detected before the administration of the remedy. The chemical analyses were made by Professor Outram, and the results of his experiments are perfectly reliable. All the patients began to improve rapidly after this treatment was adopted, although they had previously resisted the ordinary means. No bad effects resulted from the long-continued use of the remedy. In two cases, as M. Melsens suggests may occur, the symptoms were at first slightly aggravated,—one of them was profusely salivated while under treatment, and the other slightly so. One patient also suffered from coryza and gastric disturbance for a few days; but the treatment was only suspended for a short time. One patient was under the influence of the iodide of potassium for six months, one for five and a half, and another for four months.

In Case 6, the urine was examined shortly after the treatment was commenced, and merely a trace of lead was detected. The quantity sensibly increased, until it was clearly shown both in the urine and saliva; and, as the patient convalesced, it disappeared entirely, and the iodide of potassium was found abundantly in the saliva. In Case 5, we did not suspect the existence of lead poisoning until after the patient had been put upon treatment for constitutional syphilis. While under this treatment, a well-defined "blue line" appeared upon the gums. The urine was then examined, and found to contain lead.

Of the twenty-three cases treated by iodide of potassium, sixteen were discharged cured, and three so far relieved as to be able to resume their ordinary duties; four are still under treatment, and are gradually improving. Thirteen of the patients suffered from lead colic, complicated with neuralgia, anthralgia, &c.; four had paralysis of the wrists, and in six the paralysis was general.—ED.]

Besides the treatment of lead-poisoning by chemical antidotes, other remedial agents usually require also to be employed, especially cathartics and opiates. The best cathartics (in addition to the sulphates above mentioned) are castor and croton oils; although many practitioners rely on a combination of sulphate of magnesia and senna. Croton oil, which was recommended by Dr. Kinglake, has proved most successful in the hands of Rayer, Tanquerel, Andral, and others. Opium is used with great benefit to relieve pain and cramps. When vomiting is very troublesome, and liquid medicines do not remain on the stomach, we may give the compound extract of colocynth or croton oil, with opium, in the form of pill. In several cases in which the pulse was full and strong, the face flushed, and the tongue furred and dry, I have used blood-letting with evident advantage.

In the after-treatment of lead paralysis there are two important remedies which deserve trial, namely strychnia, or the alcoholic extract of nux vomica, and electricity. They require to be cautiously but perseveringly employed. Mercury has been recommended by Dr. Clutterbuck.

obtained, is called *flowers of lead* (*flores plumbi*).
exposed to a current of air, it is rapidly oxidated and
protoxide of this metal. The oxidated skimmings are deno
These, when fused at a bright red heat, are separated from
metallic lead; the fused oxide forms, on solidifying, a bric
readily separates into crystalline scales: these constitute *li*
rum.) Litharge is obtained as a secondary product in the
gentiferous lead. The alloy is melted on a porous vessel, ca
(*cineritum*), and exposed to the blast of a bellows, by
oxidised, half vitrified, and driven off into hard masses of a
in that state is called *litharge* or *silver stone*.[4]

PROPERTIES.—Oxide of lead appears to be both dimorphou
Thus it occurs in the form of pale yellow rhombic octohedr
in that of red cubes, and also in that of a red amorphou
Houton-Labillardière and Payen have obtained anhydrous o
form of white crystals. Its colour may be white, yellow, or
to the mode of preparation. As usually met with it is
reddish-yellow powder. There are several commercial forms
these is yellow, and is termed *massicot* (*cerussa citrina*).
(*plumbi oxydum semivitreum, plumbi oxydum*, D.), it i
(*lithargyrum*). This occurs in the form of yellow or reddis
and, according to its colour, is called *gold litharge* (*litha*
vel chrysitis;) or *silver litharge* (*lithargyrum argentu*
According to Leblanc red or gold litharge does not owe its
sence of minium; for if it be melted and cooled suddenly it
whereas if it be cooled slowly it acquires a red colour. Oxid
and at a very high temperature volatile. It is almost insolu
is said that this liquid will take up about $\frac{1}{7000}$th pa
that it acquires therefrom alkaline properties. Oxide of le
alkalies and earths, forming salts called *plumbites*.

Characteristics.—Heated on charcoal by the blow-pipe, it
to the metallic state. It is blackened by hydrosulphuric a

COMPOSITION.—Oxide of lead is thus composed:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Berzelius.*	*Berthier.*
Lead	1	104	92·857	92·828	93·3
Oxygen	1	8	7·143	7·172	6·7
Oxide of Lead	1	112	100·000	100·000	100·0

PURITY.—The oxide of lead is enumerated among the articles of Materia Medica in the London Pharmacopœia.

It is almost entirely soluble in diluted nitric acid. The solution is blackened by hydrosulphuric acid. That which is precipitated from this solution by potash is white, and is dissolved by an excess of the precipitant. From 100 grains of this oxide dissolved in nitric acid, and the solution precipitated by sulphate of soda, there are obtained in the dry precipitate 135 grains of sulphate of lead.—*Ph. Lond.*

Fifty grains dissolve entirely, without effervescence, in a fluidounce and a half of pyroligneous acid; and the solution, precipitated by 53 grains of phosphate of soda, remains precipitable by more of the test.—*Ph. Ed.*

The presence of a carbonate would be indicated by effervescence on the addition of acetic acid.

PHYSIOLOGICAL EFFECTS.—Inhaled in the form of vapour or fine dust, it produces the before-mentioned constitutional effects of lead. The effects of this substance, when swallowed, are but little known. It produces very slightly irritant properties. "The experimentalists of Lyons found litharge to be irritant in large doses of half an ounce."[1] From its external use ill consequences have sometimes resulted.

USES.—Oxide of lead is never employed internally. Litharge is sometimes sprinkled over ulcers, as an astringent and desiccating substance. In pharmacy, it is used in the preparation of *emplastrum plumbi, ceratrum saponis, acetas plumbi,* and *liquor plumbi diacetatis.*

1. EMPLASTRUM LITHARGYRI, D.—(See *post,* EMPLASTRUM PLUMBI.)

2. CALCIS PLUMBIS; *Plumbite of Lime.*—This is prepared by boiling oxide of lead with cream of lime. Plumbite of lime is employed as a *hair dye.* The lead of the plumbite unites with the sulphur contained in the organic substance composing the hair, and forms the black sulphuret of lead.

131. PLUMBI OXYDUM RUBRUM.—RED OXIDE OF LEAD.

Formula $Pb^3O^4=2PbO,PbO^2$. *Equivalent Weight* 344.

HISTORY.—It is doubtful whether the ancients were acquainted with this compound, as the substance which Pliny[2] called *minium* was cinnabar. He describes, however, an inferior kind, which he terms *minium secundarium,*[3] and which may be, perhaps, the red oxide of lead. Dioscorides[4] distinguished minium from cinnabar. Besides *minium,* there are several other names for red

---

[1] Christison. *op. cit.* p. 509.

[2] *Hist Naturalis,* lib. xxxiii. cap. 40, ed. Valp.

[3] *Idem.*

[4] Lib. v. cap. 109.

130. PLU

History.—The
employed the semi-
Pliny[3] both mention
Preparation.—
vapour, burns with
obtained, is called
exposed to a curren
protoxide of this me
These, when fused a
metallic lead; the
readily separates int
rum.) Litharge is
gentiferous lead.
(*cineritum*), and ex
oxidised, half vitrifie
in that state is calle
Properties.—Ox
Thus it occurs in th
in that of red cube
Houton-Labillardièr
form of white crystal
to the mode of pre
reddish-yellow powd
these is yellow, and i
(*plumbi oxydum se*
(*lithargyrum*). Th
and, according to its
vel chrysitis;) or
According to Leblan
sence of minium; fo
whereas if it be coole
and at a very high te
is said that this l
that it acquires ther
alkalies and earths, f
Characteristics.—
to the metallic state.
phuret of lead, PbS.
of nitrate of lead, Pb
stated. The varietie
liarities.

1
2
3
4

Composition.—Oxide of lead is thus composed:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Berzelius.*	*Berthier.*
Lead	1	104	92·857	92·828	93·3
Oxygen	1	8	7·143	7·172	6·7
Oxide of Lead	1	112	100·000	100·000	100·0

Purity.—The oxide of lead is enumerated among the articles of Materia Medica in the London Pharmacopœia.

It is almost entirely soluble in diluted nitric acid. The solution is blackened by hydrosulphuric acid. That which is precipitated from this solution by potash is white, and is dissolved by an excess of the precipitant. From 100 grains of this oxide dissolved in nitric acid, and the solution precipitated by sulphate of soda, there are obtained in the dry precipitate 135 grains of sulphate of lead.—*Ph. Lond.*

Fifty grains dissolve entirely, without effervescence, in a fluidounce and a half of pyroligneous acid; and the solution, precipitated by 53 grains of phosphate of soda, remains precipitable by more of the test.—*Ph. Ed.*

The presence of a carbonate would be indicated by effervescence on the addition of acetic acid.

Physiological Effects.—Inhaled in the form of vapour or fine dust, it produces the before-mentioned constitutional effects of lead. The effects of this substance, when swallowed, are but little known. It produces very slightly irritant properties. "The experimentalists of Lyons found litharge to be irritant in large doses of half an ounce."[1] From its external use ill consequences have sometimes resulted.

Uses.—Oxide of lead is never employed internally. Litharge is sometimes sprinkled over ulcers, as an astringent and desiccating substance. In pharmacy, it is used in the preparation of ***emplastrum plumbi, ceratrum saponis, acetas plumbi,*** and ***liquor plumbi diacetatis.***

1. EMPLASTRUM LITHARGYRI, D.—(See *post,* Emplastrum Plumbi.)

2. CALCIS PLUMBIS; *Plumbite of Lime.*—This is prepared by boiling oxide of lead with cream of lime. Plumbite of lime is employed as a ***hair dye.*** The lead of the plumbite unites with the sulphur contained in the organic substance composing the hair, and forms the black sulphuret of lead.

131. PLUMBI OXYDUM RUBRUM.—RED OXIDE OF LEAD.

Formula $Pb^3O^4=2PbO,PbO^2$. *Equivalent Weight* 344.

History.—It is doubtful whether the ancients were acquainted with this compound, as the substance which Pliny[2] called ***minium*** was cinnabar. He describes, however, an inferior kind, which he terms ***minium secundarium,***[3] and which may be, perhaps, the red oxide of lead. Dioscorides[4] distinguished minium from cinnabar. Besides ***minium,*** there are several other names for red

---

[1] Christison, *op. cit.* p. 509.

[2] *Hist Naturalis,* lib. xxxiii. cap. 40, ed. Valp.

[3] *Idem.*

[4] Lib. v. cap. 109.

oxide of lead. I
termed *deutoxide*
NATURAL HIST
Siberia, and some
PREPARATION.—
(massicot or lithar
oxygen and is co
The finest minium
the carbonate.[1]
"Orange" in com
not been accurately
pared with the "R

PROPERTIES.—
gives out oxygen g
is 8·62.

Characteristics
the yellow oxide (P
yellow protoxide, a
nitrate of the prot
peroxide of lead, P
lead, white sulphat
$2PbO + PbO,SO^3$.

"Entirely soluble in
a brown powder being

COMPOSITION.—T

	Atoms.	Eq. Wt.
Lead......	3	312 ..
Oxygen....	4	32 ..
Red Lead..	1	344 ..

Dumas[2] has show
but consists of varia
have been confirmed
mere mixture of prot
well as by the fact t
of lead, which is cap
represent the comp
PbO,PbO^2; $5PbO,P$

ADULTERATION.—
substances (as brick
to detect this by boil
small quantity of nit
leaving the foreign m

PHYSIOLOGICAL EF
of lead. It is but li
directs it to be empl
p. 385).

---

[1] G
[2] *A*
[3] *P*

132. PLUMBI CARBONAS.—CARBONATE OF LEAD.

Formula PbO,CO^2. *Equivalent Weight* 134.

HISTORY.—*Ceruse* (*cerussa*), or *white lead*, was known to the ancients. The Greeks called it *ψιμύθιον*, or *ψιμμύθιον*, and later *ψιμίθιον*. It was employed by Hippocrates[1] in medicine. Theophrastus[2] describes the method of preparing it by exposing lead to the fumes of vinegar in earthen vessels. Dioscorides[3] and Pliny[4] also notice this mode of procuring it. Besides the preceding, white lead has also been known by other names, such as *magistery of lead* (*magisterium plumbi*), *flake white*, *subcarbonate of lead*, &c.

NATURAL HISTORY.—Neutral or monocarbonate of lead is found native, both crystallized and massive, in Scotland, England, &c. It is called *white lead ore*.

PREPARATION.—Various methods are described for the preparation of carbonate of lead, but the products obtained by some of the processes differ from those procured by others.

1. *Neutral carbonate of lead* is obtained by adding a solution of an alkaline carbonate to a solution of acetate or nitrate of lead. If acetate of lead and carbonate of potash be employed, the reactions are as follows:— $PbO,\overline{A} + KO,CO^2 = KO,\overline{A} + PbO,CO^2$. Procured in this way it is deficient in *body*, owing to the transparency of the crystalline grains; and it is not, therefore, fitted for the use of the painter, who requires a dense and opaque carbonate. The compounds which possess the required properties expressed by the term body, are basic carbonates, composed of the neutral carbonate and the hydrated oxide.

2. *Basic carbonate of lead*, called in commerce *ceruse*, or *white lead*, is prepared in various ways.

a. By decomposing a subsalt of lead by a stream of carbonic acid. At Clichy, in France, it is obtained by transmitting a stream of carbonic acid through a solution of subacetate of lead. The precipitate, according to Hochstetter, consists of $2(PbO, CO^2) + PbO,HO$. Pelouze and Fremy[5] represent it as the neutral carbonate: $3PbO,\overline{A} + 2CO^2 = 2(PbO,CO^2) + PbO,\overline{A}$. The residual neutral acetate of lead is boiled with excess of litharge, and thereby converted into the tribasic acetate, which is used for the preparation of another portion of white lead. A modification of the process has been employed by Messrs Gossage and Benson, of Birmingham. Finely powdered litharge is moistened, mixed with about $\frac{1}{100}$th part of acetate of lead, and decomposed, during constant stirring, by carbonic acid. Messrs. Button and Dyer substituted subnitrate of lead for subacetate, and decomposed by carbonic acid. In all the above processes, the carbonic acid used may be obtained by the combustion of coke, or from a lime-kiln.

b. By exposing plates, or bars, or other forms of lead, to the vapour of acetic acid, and, at the same time, to air loaded with carbonic acid gas. In this country white lead is extensively manufactured by the old or *Dutch*

---

[1] *De Morbis*, lib. ii.

[2] Theophrastus's *History of Stones*, by Sir J. Hill, 2d edit. p. 223, Lond. 1774.

[3] Lib. v. cap. ciii.

[4] *Hist. Nat.* lib. xxxiv.

[5] *Cours de Chimie Générale*, t. 2nde, p. 487, 1848.

process, which, it
obtained by most

In the *Dutch proc*
bars, or into the for
and from a quarter t
another in the upper
bottom of which the
by side, on the floor
and spent tan (groun
covered with loose p
former; and thus a s
ranges of the pots
the tan. Several ra
stack containing abou
the stack is built up
temperature of the i
acetic acid is slowly
folds of lead, graduall
tate is successively fo
of carbonic acid furni
In the course of from
the stacks, the lead is
castings is retained, b
masses of carbonate o
only to a certain dept
version being unequal
ferent seasons, temper
that they are successi
gratings or cakes are
lead) is crushed and b
remain, is easily separa
ground up into a thin
triation or successive
is then dried in woode
brought to the state o
which the microscope
character (Brande)."

"If intended for the
oil; and it is found th
sistence with 8 pounds
for the same purpose;
so much more body tha

"It is sometimes su
to form the carbonate
acid; but this is evide
exist in the whole quan
and in 100 pounds of
whereas 6740 pounds
50 tons of lead (the a
There can be no doubt,
and that the oxygen is
sphere: the principal a

---

[1] At one manufactory
mould. In the act of coo
was essential to the succe
corroded as the crystallise

[2] At the manufactory b
twelve weeks.

[3] In some manufactorie

subacetate of lead, which are successively decomposed by the carbonic acid: the action is, however, of a very remarkable description, for even masses of lead, such as blocks of an inch or more in thickness, are thus gradually converted through and through into carbonate, so that if due time is allowed there is no central remnant of metallic lead. The original texture of the lead is much concerned in the extent and rapidity of the conversion. Rolled or sheet lead will not answer, and the gratings, coils, and stars, which are employed, are all of cast-lead. The purest metal is also required, for if it contains iron, the resulting white lead acquires a tawny hue, and if a trace of silver, it acquires a perceptible dinginess when it is subjected to the action of light" (Brande).

[A patent was taken out in 1849, by Mr. J. E. Rodgers,[1] for an improved process of making white lead. The principal features of this process are, first, the use of a chamber capable of being made air-tight, when required, and into which the supply of carbonic acid gas, acetic acid, or aqueous vapours may be controlled or regulated; secondly, the introduction of steam into the converting chamber, either alone or combined. Pieces of lead are suspended in this chamber over troughs containing a fluid in a state of viscous or acetous fermentation. Steam-pipes from a boiler open into this chamber so as to introduce aqueous vapour about three times in twenty-four hours.—ED.]

The presence of copper in the lead alters the appearance of the resulting white lead. A minute quantity of lamp black, indigo, or some other blue pigment, is usually added to white lead at the time of grinding it with oil, to destroy the yellow tint. By conversion into white lead, the metal usually gains an increase in weight of about a fourth part.

3. By the mutual action of lead, water, and carbonic acid, a hydro-carbonate of lead is produced. The crust formed in leaden cisterns and pipes, by the action of a pure water and air containing carbonic acid, is of this kind (see p. 292). [It is a crystalline compound of carbonate and hydrated oxide of lead, $2(PbO,CO^2) + PbO,HO$.—ED.]

Some years ago, a manufactory for white lead, founded on this principle, was established at Pimlico, but it was soon abandoned. Granulated lead was agitated in water, and the resulting hydrated oxide of lead was exposed to the action of carbonic acid (Brande).

PROPERTIES.—Both the carbonate and subcarbonates of lead are white, effervesce with nitric acid, are blackened by sulphuretted hydrogen or the hydrosulphurets, give out their carbonic acid, and are converted into the yellow oxide, when heated. By the aid of carbonic acid, they are very slightly soluble in water.

α. *Of the neutral carbonate* (PbO,CO^2).—The native carbonate is found crystallised in forms derived from a right rhombic prism. The artificial carbonate is a white amorphous powder.

β. *Of the subcarbonates.*—These are compounds of the neutral carbonate with the hydrated oxide. They are dull, white, and dense. They possess great covering power, or *body*. The dicarbonate ($2PbO, CO^2,HO$), however, does not, according to Bonsdorff, possess the covering power of common white lead. The smaller the quantity of hydrated oxide present, the less readily does the subcarbonate become yellow or brownish by exposure to air and light. Examined by the microscope, none of the subcarbonates present any traces of crystalline texture.

Characteristics.—Heated on charcoal by the blowpipe flame, the carbonates of lead yield soft malleable globules of metallic lead, usually surrounded by a small quantity of the yellow oxide (PbO). Sulphuretted hydrogen and the hydrosulphurets blacken them (PbS). They dissolve in nitric acid with effer-

---

[1] *Pharmaceutical Journal*, 1849-50, p. 410.

vescence: the cl
neutral carbonate
titative analysis.

COMPOSITION.-
with oxide of le
(PbO,HO). T
different in differ

α. Of the neu
well as of the art

Oxide of Lead
Carbonic Acid

Carbonate o

β. Of the sub

According to
united influence

Oxide of Lead
Carbonic Acid
Water.........

Dicarbonate

Its composition,

Dr. Christison
united agencies of

Commercial w
In a general w
2(PbO,CO²)+P
less than this.

Atoms. *E*

Oxide of Lead 3 ....
Carbonic Acid 2 ....
Water........ 1 ....

White Lead .. 1 ....

In other sa
less than this.
others, 2(PbO,C
white lead, and
of oxide of lead
to 12·99.

PURITY.—Car
adulterated with
These are detect
is by some used
suspected substa

USES.—According to Mr. Tuson,[1] it is a valuable agent in the treatment of cancerous affections. It both allays pain and restrains morbid action. In hysterical hyperæsthesia of the breast, and in cases where pain is excited by the pressure of a tumour on the nerves of the part, it proves highly successful. It is also useful in allaying inflammation.

USE.—It is employed in the form both of solution and of ointment. The *solution* is prepared by dissolving one drachm of the chloride in a pint of water. The *ointment* consists of ʒj. of chloride and ℥j of simple cerate.

ANTIDOTES.—These are the same as those given in other forms of lead poisoning.

134. PLUMBI IODIDUM.—IODIDE OF LEAD.

Formula PbI. *Equivalent Weight* 230.

HISTORY.—This compound was introduced into medicine by Cottereau and Verdé Delisle.

PREPARATION.—The three Colleges give directions for the preparation of it.

The *London College* orders of Acetate of Lead, ℥viij.; Iodide of Potassium, ℥vij.; Distilled Water, *cong.* j. Dissolve the Acetate of Lead in six pints of the Water, and strain; and to these add the Iodide of Potassium first dissolved in two pints of the water. Wash what is precipitated with cold distilled water, and dry it. Keep the compound from light.

By the mutual action of one equivalent of dry acetate of lead, and one equivalent of iodide of potassium, we obtain one equivalent of iodide of lead and one equivalent of acetate of potash. $Pb,O\bar{A}+KI=PbI+KO,\bar{A}$. The reacting proportions of iodide of potassium and crystallised acetate of lead are 165 parts of the former and 190 parts of the latter. [These are about the proportions recommended by the London College.—ED.]

If excess of acetate of lead be employed, a portion of oxiodide of lead (PbI,PbO) is precipitated with the iodide, and if a deficiency, a compound of iodide of lead and potassium is retained in solution (2KI,3PbI.) If the acetate of lead employed to decompose the iodide of potassium be contaminated with subacetate (as the sugar of lead of commerce usually is) a portion of oxiodide of lead (PbI,PbO) precipitates along with the iodide. This may be prevented by carefully saturating the subacetate with acetic acid. But if excess of acetic acid be used, the precipitated iodide of lead contains a slight excess of iodine (*superiodide of lead.*)

The *Edinburgh College* orders of Iodide of Potassium, and Nitrate of Lead, of each, ℥j.; Water, Oiss.; dissolve the salts separately, each in one half of the water; add the solutions; collect the precipitate on a filter of linen or calico, and wash it with water. Boil the powder in three gallons of water acidulated with three fluidounces of pyroligneous acid. Let any undissolved matter subside, maintaining the temperature near the boiling point; and pour off the clear liquor, from which the iodide of lead will crystallise on cooling.

The *Dublin College* adopts the Edinburgh proportions, but orders two pints of distilled water. Dissolve with the aid of heat the nitrate of lead in a pint, and the iodide of potassium in half a pint of the water, and mix the two solutions when cold. Decant the clear solution when the precipitate has subsided, and having transferred the latter to a filter,

---

[1] *Lancet*, Jan. 13, 1844.

℥vj. Dissolve th
three pints of Di
liquors being mix
cold, and dry it.

In this proc
equivalent of c
cipitated, and o
+ NaCl = PbCl
more chloride o
there must be s
PROPERTIES.-
magisterium s
parts of boiling
transparent hor
Characteris
nitrate of silve
shown to be a c
mentioned tests

It is sparingly
almost entirely de
phuric acid it is b

COMPOSITION

Lead........
Chlorine ...

Chloride

PHYSIOLOGIC
and caustic. I
and fluids, form
a paralysing a
the effects of t
[The chloride o
ing. In recen
obtained as mu
of the water.
taining no car
chlorides were i
the principal mi
was pumped u
It was clear, f
indicated the p
proportion. B
tible change.
expense of the
present in suff
reason to believ
this water had

USES.—According to Mr. Tuson,[1] it is a valuable agent in the treatment of cancerous affections. It both allays pain and restrains morbid action. In hysterical hyperæsthesia of the breast, and in cases where pain is excited by the pressure of a tumour on the nerves of the part, it proves highly successful. It is also useful in allaying inflammation.

USE.—It is employed in the form both of solution and of ointment. The *solution* is prepared by dissolving one drachm of the chloride in a pint of water. The *ointment* consists of ʒj. of chloride and ℥j of simple cerate.

ANTIDOTES.—These are the same as those given in other forms of lead poisoning.

134. PLUMBI IODIDUM.—IODIDE OF LEAD.

Formula PbI. *Equivalent Weight* 230.

HISTORY.—This compound was introduced into medicine by Cottereau and Verdé Delisle.

PREPARATION.—The three Colleges give directions for the preparation of it.

The *London College* orders of Acetate of Lead, ℥viij.; Iodide of Potassium, ℥vij.; Distilled Water, *cong.* j. Dissolve the Acetate of Lead in six pints of the Water, and strain; and to these add the Iodide of Potassium first dissolved in two pints of the water. Wash what is precipitated with cold distilled water, and dry it. Keep the compound from light.

By the mutual action of one equivalent of dry acetate of lead, and one equivalent of iodide of potassium, we obtain one equivalent of iodide of lead and one equivalent of acetate of potash. $\mathrm{Pb,O\bar{A}+KI=PbI+KO,\bar{A}}$. The reacting proportions of iodide of potassium and crystallised acetate of lead are 165 parts of the former and 190 parts of the latter. [These are about the proportions recommended by the London College.—ED.]

If excess of acetate of lead be employed, a portion of oxiodide of lead (PbI,PbO) is precipitated with the iodide, and if a deficiency, a compound of iodide of lead and potassium is retained in solution (2KI,3PbI.) If the acetate of lead employed to decompose the iodide of potassium be contaminated with subacetate (as the sugar of lead of commerce usually is) a portion of oxiodide of lead (PbI,PbO) precipitates along with the iodide. This may be prevented by carefully saturating the subacetate with acetic acid. But if excess of acetic acid be used, the precipitated iodide of lead contains a slight excess of iodine (*superiodide of lead.*)

The *Edinburgh College* orders of Iodide of Potassium, and Nitrate of Lead, of each ℥j; Water, Oiss.; dissolve the salts separately, each in one half of the water; add the solutions; collect the precipitate on a filter of linen or calico, and wash it with water. Boil the powder in three gallons of water acidulated with three fluidounces of pyroligneous acid. Let any undissolved matter subside, maintaining the temperature near the boiling point; and pour off the clear liquor, from which the iodide of lead will crystallise on cooling.

The *Dublin College* adopts the Edinburgh proportions, but orders two pints of distilled water. Dissolve with the aid of heat the nitrate of lead in a pint, and the iodide of potassium in half a pint of the water, and mix the two solutions when cold. Decant the clear solution when the precipitate has subsided, and having transferred the latter to a filter,

---

[1] *Lancet*, Jan. 13, 1844.

wash it with the rem
exceeding 212°, and p

By the mutual r
tain nitrate of pota
The reacting propo
one atom or 165 p
materials as ordere
for the preparation
crystalline or scaly

Properties.—It
water, but readily s
separated, as the so
scales. It is fusibl
of double salts, c
potash dissolves it,
plumbate of potash
forms a colourless s

Characteristics.
lead), and afterwar
when dissolved in n
Boiled with carbon
potassium.

Composition.—I

Lead ....
Iodine ....

Iodide of I

Purity.—It shou

Pulverulent, of a yel
shining yellow scales.
and afterwards in viol
iodide of lead dissolved
the iodine has been exp
ration should not be ex
Bright yellow: five
fluidrachm of pyrolign
and golden crystals are

Physiological
iodide of lead were g
the animal suffered v
irritation were observ
from gr. v. to ℥ss.
day, when the animal
died on the eighteen
fifty grains of iodide.
intestinal evacuations

β. *On Man.*—Its effects on man have been imperfectly determined. It does not appear to act as an irritant when applied to the skin or ulcerated surfaces. Under the continued external and internal use of it, enlargements of the lymphatic glands have disappeared, from which we infer a specific influence over the glandular and lymphatic system. In some cases it appeared to occasion irritation of the stomach. I have seen constipation induced by it. After its medicinal use for several weeks I have not observed any blue line on the gums.

USES.—It has been principally employed to reduce the volume of indolent tumours, especially enlargements of the cervical, axillary, inguinal, and mesenteric glands, both scrofulous and syphilitic. In these cases it should be simultaneously employed internally and externally. I have also given it in suspected incipient phthisis. I have used it in two cases of enlarged cervical glands, but without benefit. Velpeau[1] and others, however, have been more successful. [Iodide of potassium has been employed with success in the treatment of saturnine diseases, and it appears to act by eliminating the lead through the urinary secretion (see *ante*, p. 788.)—ED.]

ADMINISTRATION.—The dose is three, four, or more grains. Dr. O'Shaughnessy[2] says, ten-grain doses are easily borne, without the slightest annoyance. Bally has given thirty grs. at a dose. It is administered in the form of pill.

UNGUENTUM PLUMBI IODIDI, L.D.; *Ointment of Iodide of Lead.* (Iodide of Lead, ℥j.; Lard, ℥viij. M.; Iodide of Lead, ʒj.; Ointment of White Wax, ʒvij. D. Rub together.)—This is applied, by way of friction, to scrofulous and other indolent swellings.

135. PLUMBI NITRAS.—NITRATE OF LEAD.

Formula PbO,NO^5. *Equivalent Weight* 166.

HISTORY.—This salt was employed in medicine two centuries ago.[3] It has had various names; such as *nitrum saturninum*, and *plumbum nitricum*.

PREPARATION.—The Edinburgh College gives the following directions for its preparation:—

Take of Litharge, ℥ivss.; Diluted Nitric Acid, Oj. Dissolve the litharge to saturation with the aid of a gentle heat. Filter, and set the liquor aside to crystallise. Concentrate the residual liquid to obtain more crystals.

Take of Litharge, in fine powder, ℥v.; Pure Nitric Acid, f℥ij.; Distilled Water, Oiij.; Dilute Nitric Acid, a sufficient quantity. To the litharge, placed in a porcelain dish, add the acid with a pint and a half of the water, and, applying a sand heat, and occasionally stirring the mixture, evaporate the whole to dryness. Upon the residue boil the remainder of the water, clear the solution by filtration, and, having acidulated it by the addition of a few drops of the dilute nitric acid, evaporate until a pellicle begins to form on its surface. The heat being now withdrawn, crystals will form, on the cooling of the solution, which should be dried on blotting-paper in a warm atmosphere, and preserved in a close bottle.—*Ph. D.*

---

[1] Lugol's *Essays*, by Dr. O'Shaughnessy, p. 206.

[2] *Ibid.* p. 207.

[3] Schroder's *Chymical Dispensatory*, by Dr. Rowland, pp. 199 and 255, Lond. 1669.

The nitric acid co
this metal. PbO+
Properties.—Th
of these. Its solutic
loudly by heat.
Characteristics.-
decrepitates and evo
yellow oxide of lead.
have been before sta
tests for lead.
Composition.—T

	Ato
Oxide of Lead	
Nitric Acid	
Crystallised Nitrate Lead	

Physiological E
other soluble salts of
its affinity for album
precipitate, compose
nitrate of lead, 1
albumen, as well as i
of potash. Applied
irritate, but promote
decomposes the chlor
fluids: its power of
phurets (with which
deodorizer.
Uses.—Two hun
remedy for asthma.[2]
hemorrhage;[3] and al
internally. In active
a pill composed of su
acid: nitrate of lead
bination I have succe
in a much shorter tir
use is as a topical ag
ulcers, cancerous, and
A solution of ten
coloured (probably
cracked nipples, and
"*Cosmétique infaill*
seins et autres."
solution. The soluti

---

[1] *Journn. de Chim. Méd.*
[2] Schroder, *op. cit.*
[3] *Act. Ac. Caes. Nat. Cu*
vol. i. p. 419, 1795.
[4] A. Gesner and Oosterdy

covered with a shield; and this is to be repeated each time after the child has done sucking. The nipple is to be carefully washed with lukewarm water before the child is put to the breast. This mode of treatment has been tried by Dr. Volz,[1] and found to be most successful. He also speaks very favourably of the use of this solution in the treatment of chapped hands and cracked lips.

Ledoyen's disinfecting fluid is a solution of one drachm of nitrate of lead in an ounce of water. It completely destroys the unpleasant odour of animal and vegetable substances which are evolving sulphuretted hydrogen and hydrosulphuret of ammonia; but there is no evidence to show that it has any power of destroying miasmata.[2] Le Maitre de Rabodanges[3] has employed the nitrate both to destroy putrid effluvia and for the preservation of animal substances. Its antiseptic power, however, is denied by the Editor of the *Pharmaceutical Journal* (vol. vii. p. 115).

ADMINISTRATION.—Nitrate of lead may be administered internally in doses of from gr. ¼ to gr. j. twice or thrice daily in the form of pill or solution. Externally, a solution of from 10 grs. to ʒj. of the salt in an ounce of distilled water is used. Nitrate of lead was introduced into the Edinburgh Pharmacopœia as the best salt for the preparation of *iodide of lead*, and it has been introduced with the same view into the last edition of the Dublin Pharmacopœia.

136. PLUMBI ACETATES.—ACETATES OF LEAD.

Five compounds of acetic acid and oxide of lead are known: of these one is the neutral acetate, and the other four are basic salts.

Hexacetate (crystallised)	$6PbO,\bar{A},3HO$
Triacetate	$3PbO,\bar{A}$
Diacetate	$2PbO,\bar{A}$
Sesquiacetate	$3PbO,2\bar{A}$
Neutral acetate (crystallised)	$PbO,\bar{A},3HO$.

Of these five acetates two only are employed in medicine, namely, the neutral acetate and the diacetate. The hexacetate is sometimes found in commercial white lead.

1. Plumbi Acetas.—Neutral Acetate of Lead.

Formula $PbO,\bar{A}$. *Equivalent Weight* 163.

HISTORY.—Raymond Lully and Isaac Hollandus were acquainted with this salt in the 13th century. It has been known by several appellations; as *sugar of lead* (*saccharum saturni*), *acetated ceruse* (*cerussa acetata*), and *superacetate of lead* (*plumbi superacetas*).

PREPARATION.—Though directions are given in the Edinburgh Pharma-

---

[1] *Medicinische Zustände*, Pforzheim, 1839 (quoted by Dierbach, *Die neuesten Entdeckungen in der Mat. Med.* Bd. 2er, S. 1225, 1843).

[2] *Pharmaceutical Journal*, vol. vii. pp. 63 and 110, 1847.

[3] *Acad. des Sciences*, 8 Juin, 1846.

Themson and others (Van Swieten,[1] Reynolds, Latham, Laidlaw,
Christison, &c.) have, however, shewn that injurious effects from th
large doses are very rare. I have repeatedly given five grains three
day for ten days, without inconvenience. This dose was taken for a for
The blue line on the gums was then very distinct, and the patie
plained of griping pains in the bowels. A young man, suffering w
moptysis, and under my care in the London Hospital, took from July
Aug. 27, 1842, 288 grs. of acetate of lead: at first in doses of 2 gr
3 grs., thrice daily. The leaden line on the gums was by no mea
marked; at least I have seen it much better marked from a smaller qua
lead. He experienced slight gripings. The hæmoptysis was most di
relieved by it. He took the lead in the form of pills in combination with
Dr. Christison has given eighteen grains daily for eight or ten days
any unpleasant symptoms whatever, except once or twice slight colic.
its employment the gums should be frequently examined, in order that t
liest appearance of the blue line, before referred to, may be detected.
ever this salt gives rise to any obvious effects, they are those of the plu
preparations in general, and which have been already described. Its me
action, therefore, is sedative and astringent.

USES.—Acetate of lead is administered *internally* to diminish the di
of the capillary vessels, and lessen circulation, secretion, and exhalation

Thus, we employ it in profuse discharges from the mucous memb
as from the lungs, alimentary canal, and even the urino-genital mem
In the mild cholera, so common in this country towards the end of su
I have found acetate of lead in combination with opium most efficacious
the chalk mixture failed. I have used this combination in a few ca
malignant cholera, and in one or two with apparent benefit. [This m
has been lately employed in the treatment of Asiatic cholera, and in som
with decided advantage.—ED.] In colliquative diarrhœa and chronic dys
it occasionally proves serviceable.[3] In phthisis it has been found ben
but only as a palliative; namely, to lessen the expectoration, check the
sweats, or stop the harassing diarrhœa. Dr. Latham[4] speaks
favourably of the use of sugar of lead and opium in checking pu
or semi-purulent expectoration. I have repeatedly seen it diminish
toration, but I have generally found it fail in relieving the night-s
though Fouquier supposed it to possess a specific power of checking
they are more frequently benefited by dilute sulphuric acid. In sangui
exhalations from the mucous membranes, as epistaxis, hæmoptysis, an
matemesis, and in uterine hemorrhage, it is employed with the vi
diminishing the calibre of the bleeding vessels, and thereby of stoppin

---

[1] *Commentaries*, vol. x. p. 236, Eng. ed. Van Swieten says colic was induced by the
drachm of lead in an emulsion every day for ten days.

[2] In the *Journ. de Chim. Méd.* (t. vi. 21e Série, p. 97), a case is related of death from th
The patient, a boy of 15 years of age, affected with a phthisical malady, took from a $\frac{1}{4}$ gr. to
four times a day, until he had taken 130 grs. without any ill effect. A month after he was
with colic, which was followed by paralysis and death.

[3] See Dr. Burke, *On the good Effects of a Mixture of Acetate of Lead and Tincture of*
in the Dysentery which occurred in Dublin in 1825, in the *Edinb. Medical and Surgical Jo*
vol. xxvi. p. 56.

[4] *Med. Trans. Coll. Phys.* v. 341.

PURITY.—It should be readily and completely soluble in water. Sulphuric acid, or sulphuretted hydrogen in excess, being added to the solution to throw down the lead, the supernatant liquor should be completely volatilized by heat: any fixed residue is impurity.

Dissolved by distilled water. By carbonate of soda a white precipitate is thrown down from the solution, and by iodide of potassium a yellow one; by hydrosulphuric acid it is blackened. Sulphuric acid evolves acetic vapours. 100 grains dissolved in water give, when sulphate of soda is added, 135 grains of sulphate of lead.—*Ph. L.*

Entirely soluble in distilled water acidulated with acetic acid: forty-eight grains thus dissolved are not entirely precipitated by a solution of thirty grains of phosphate of soda.—*Ph. Ed.*

PHYSIOLOGICAL EFFECTS. α. *On Vegetables.*—Marcet found the solution of acetate of lead injurious to plants; but Wiegmann declares it to be inert, and ascribes its inertness to the formation of an insoluble salt (carbonate) of lead by the carbonic acid of the roots of the plants.

β. *On Animals.*—Orfila[1] found that in large doses the acetate of lead acted on dogs as an irritant, and caused vomiting, pain, and death. When the action was slower, and absorption took place, an affection of the nervous system was observed, marked by difficult progression, and, in some cases, convulsive movements. The mucous membrane lining the alimentary canal was found whitened (owing to the chemical influence of the poison), and, where the action was more prolonged, reddened. Injected into the veins, or applied to wounds, it affects the nervous system. Schloepfer[2] produced colica pictonum, paralysis, and convulsions in dogs, by the repeated use of small doses. Dr. A. T. Thomson[3] gave successively, one, two, three, and six drachms to a dog without any ill effect.

γ. *On Man.*—Applied to ulcers, mucous membranes, or other secreting surfaces, it acts as a desiccant and astringent. It reacts chemically on the albumen of the secretions and of the living tissues, and forms therewith compounds which are for the most part insoluble in water and acids.[4] Hence the difficulty with which this salt becomes absorbed. Some of its compounds with organic substances are, however, rendered soluble in water by acids (as the acetic, hydrochloric, and lactic). In large quantities, acetate of lead taken into the stomach acts as an irritant, and causes symptoms of inflammation of the stomach, viz. vomiting, burning in the gullet and stomach, and tenderness at the pit of the stomach; but these are usually accompanied with colica pictonum, and are not unfrequently followed by convulsions, coma, or local palsy.[5] Ten grains taken daily for seven days caused tightness of the breast, metallic taste, constriction of the throat, debility, sallow countenance, slow respiration and circulation, turgid and tender gums, ptyalism, tightness and numbness in the fingers and toes, no nausea, pains of the stomach and abdomen, bowels confined.[6] The observations of Dr. A. T.

---

[1] *Toxicol. Gén.*

[2] Quoted by Dr. Christison.

[3] *London Medical Gazette*, x. 691.

[4] Dr. C. G. Mitscherlich, *Brit. Ann. of Med.* i. 204.

[5] Christison, *Treatise on Poisons.*—In a recent case, an ounce of acetate of lead in solution caused, in a young girl, collapse and syncope, followed by vomiting and convulsions. Orfila detected lead in the urine (*Pharm. Trans.* No. vi. p. 119).

[6] Laidlaw, *Lond. Med. Repos.* N. S. vi. 292.

Themson and othe
Christison, &c.) hav
large doses are ver
day for ten days, wit
The blue line on
plained of griping
moptysis, and under
Aug. 27, 1842, 28
3 grs., thrice daily.
marked; at least I
lead. He experienc
relieved by it. He t
Dr. Christison has g
any unpleasant symp
its employment the
liest appearance of t
ever this salt gives r
preparations in gene
action, therefore, is

USES.—Acetate o
of the capillary vesse

Thus, we employ i
as from the lungs, a
In the mild cholera,
I have found acetate
the chalk mixture fa
malignant cholera, an
has been lately emplo
with decided advantag
it occasionally proves
but only as a palliati
sweats, or stop th
favourably of the u
or semi-purulent exp
toration, but I have
though Fouquier sup
they are more frequen
exhalations from the
matemesis, and in
diminishing the calibr

---

[1] *Commentaries*, vol. x. p.
drachm of lead in an emulsi

[2] In the *Journ. de Chim.*
The patient, a boy of 15 yea
four times a day, until he ha
with colic, which was followe

[3] See Dr. Burke, *On the*
in the Dysentery which occur
vol. xxvi. p. 56.

[4] *Med. Trans. Coll. Phys.*

discharge: and experience has fully established its utility.[1] It may be employed in both the active and passive states of hemorrhage. It is usually given in combination with opium.

In bronchitis, with profuse secretion, it proves exceedingly valuable.[2] It has been employed also as a remedy for mercurial salivation.[3] It has been applied for this affection in the form of gargle by Sommé.[4] Unless care be taken to wash the mouth carefully after its use, it is apt to blacken the teeth. On the same principles that we administer it to check excessive mucous discharges, it has been employed to lessen the secretion of pus in extensive abscesses attended with hectic fever. [Drs. Neuhold and Hasserborne[5] have used the acetate of lead in enemata, in cases of strangulated hernia, as first recommended by Neuber and Peitl, and have found great advantage from it. The quantity used has been from ten to forty grains in from six to twenty-four ounces of warm water.—ED.]

There are some other cases in which experience has shown that acetate of lead is occasionally serviceable, but in which we see no necessary connection between its obvious effects on the body and its remedial powers; as in epilepsy, chorea, and intermittents.

As a *topical* remedy, we use acetate of lead as a sedative, astringent, and desiccant. An aqueous solution of it is applied to inflamed parts, or to secreting surfaces, to diminish profuse discharges. Thus, we use it in phlegmonous inflammation, in ophthalmia, in ulcers with profuse discharges, in gonorrhœa, and gleet. In the sloughing and ulceration of the cornea which attend purulent and pustular ophthalmia, its use should be prohibited, as it forms a white compound which is deposited on the ulcer, to which it adheres tenaciously, and in the healing becomes permanently and indelibly imbedded in the structure of the cornea. The appearance produced by this cause cannot be mistaken: its chalky impervious opacity distinguishes it from the pearly semi-transparent structure of even the densest opacity produced by common ulceration.[6] The white compound consists of oxide (acetate?) of lead, animal matter, much carbonate of lead, traces of phosphate and chloride of the same metal.[7] [Acetate of lead, applied in the solid form or in strong solution, is stated to have been found of great service in the treatment of granular conjunctivitis by M. Cunin,[8] of Brussels. The acetate of lead is, according to M. Cunin, preferable to the nitrate of silver in many cases in which the latter is now employed; but in the following volume of the *Bulletin* (p. 37) is related a case of severe inflammation and destruction of the cornea arising from the above application.—ED.]

A solution of acetate of lead may be employed as a disinfectant instead of the nitrate.

ADMINISTRATION.—Acetate of lead may be administered internally in doses of one or two grains to eight or ten grains, repeated twice or thrice daily.

---

[1] Reynolds, *Trans. of Coll. Phys. London*, iii. 217; Davies, *Med. and Phys. Journ.* Jan. 1808, p. 8; also, Mitchell, *ibid.* p. 69; and Latham, *op. cit.*

[2] Henderson, *Lond. Med. Gaz.* May 8, 1840.

[3] Daniell, *Lond. Med. Repos.* N. S. vi. 308.

[4] *Archiv Gén. de Méd.* i. 483.

[5] *Union Medicale*, Nov. 30, 1848; and *Edinburgh Monthly*, Feb. 1849.

[6] Dr. Jacob, *Dublin Hospital Reports*, v. 369; also, Velpeau, *Lond. Med Gazette*, Oct. 5, 1839.

[7] Dr. Apjohn, *op. cit.* p. 402.

[8] *Bulletin Thérap.* t. xxxvii. p. 182

Dr. A. T. Thomso
prevent its change in
It is usually exhibit
opium. Acetate o
produce acetate of
Experience, however,
bination. Sulphuri
and soda, and alu
Sulphuric acid, the s
facilitate the produ
water, which contai
with this salt. Th
account of the carbo

1. **CERATUM PLU**
E. D.; *Unguentum*
of Lead, powdered,
eighteen fluidounces
rately rubbed with t
incorporated, *L.* Si
℥j. *E.* Ointment of
excellent soothing a
blistered surfaces.

2. **PILULÆ PLUMB**
(Acetate of Lead, *s*
about one part. B
four-grain pills.—T
opium).—Each pill c
of opium. I have b
is effected between ac
most efficacious one.
countenancing the c
the pill is highly obje
mucus, obstinate dia
most valuable. Dos

2. Pl

F

History.—This c
century. It owes i
bestowed on its soluti
He called it *extrac*
termed *Goulard's ex*
Preparation.—T

---

[1] *A Treatise on the Effe*
Saturn, for different Chirur

the preparation of the solution of diacetate of lead (*liquor plumbi diacetatis*, L.; *plumbi diacetatis solutio*, E.; *plumbi subacetatis liquor*, D.)

The *London College* orders, of Acetate of Lead, lb. ij. and ℥iij.; Oxide of Lead, rubbed to powder, lb. j. and ℥iv.; Water, Ovj. Boil them for an hour, frequently stirring, and when the liquor is cold, add of distilled Water as much as may be sufficient to measure with it six pints; lastly, strain [the solution].

The *Edinburgh College* employs of Acetate of Lead, ℥vj. and ʒvj.; Litharge, in fine powder, ℥iv.; Water, Oiss.

The acetate of lead combines with an additional equivalent of oxide of lead to form the diacetate. This process yields an uniform product.

The *Dublin College* employs of Acetate of Lead, ℥vj.; Litharge, in fine powder, ℥iv.; Distilled Water, Oij. Dissolve the acetate of lead in the water, and, when the solution is raised to its boiling temperature, add the litharge in successive portions, and boil gently for half an hour. Add now as much distilled water as will supply what has been lost by evaporation, and filter through paper into a bottle, which should be furnished with an air-tight stopper. The sp. gr. of this solution is 1·066.

PROPERTIES.—It is a transparent and colourless liquid. Prepared according to the London Pharmacopœia, its specific gravity is 1·260: according to the Dublin Pharmacopœia, it is 1·066. Its taste is sweet and astringent. By evaporation it with difficulty yields crystals of the diacetate of lead, which, according to Dr. Barker, are flat rhomboidal prisms with dihedral summits.

Characteristics.—The presence of lead and acetic acid in this solution may be known by the tests before mentioned for acetate of lead. From the neutral acetate it is distinguished by the copious precipitate which it produces with carbonic acid, as well as with mucilage.[1] Solution of the diacetate of lead forms a precipitate with most vegetable colouring matters.

COMPOSITION.—This liquid is an aqueous solution of the diacetate of lead. The solid hydrated diacetate having a crystalline aspect, has, according to Dr. Thomson,[2] the following composition:—

	Atoms.	*Eq. Wt.*	*Per Cent.*
Oxide of Lead	2	224	61·37
Acetic Acid	1	51	13·97
Water	10	90	24·66
Solid Hydrated Diacetate of Lead	1	365	100·00

But, according to Schindler, the crystals dried at a temperature under 122,°F., consist of $2PbO,\bar{A},2HO$; but dried at 158°, F., their composition is $2PbO,\bar{A},HO$.

PURITY.—When this compound has been prepared with common vinegar, it has a brown colour. The properties of the pharmacopœial preparation are as follows:—

It is a clear liquid. Its sp. gr. is 1·260. Its other properties are similar to those of the acetate of lead.—*Ph. Lond.*

A copious precipitate is gradually formed when the breath is propelled through it by means of a tube.—*Ph. Ed.*

PHYSIOLOGICAL EFFECTS.—Its effects are analogous to those of the acetate.

---

[1] [A solution of gum acacia precipitates abundantly a solution of diacetate of lead, but gives no precipitate in a solution of the neutral acetate.—ED.]

[2] *First Principles of Chemistry*, vol. ii. p. 373.

Its chemical action o
fibrine. In a soluti
of albumen and diac
caused in an albumi
71·67, and *trisace*
excess of the solutio
several salts (as acet
A. T. Thomson[2] ass
has more tendency t
readily converted int
local astringent an
external use.

Uses.—It is empl
inflammation, to ch
mucous surfaces, a
affected with either
to inflamed tendons,
contusions, sprains,
surfaces, ulcers, and
administered internal
and nitrate, may be

Administration.-
or mixed with fatty

1. LIQUOR PLUMB
compositus, D. (Sol
Proof Spirit, ʒij. M
Spirit, of each f℥ij.;
a well-stopped bottle,
saturn, or *vegeto-m*
the shops, *goulard*
when prepared with
formation of carbonat
less turbid if it be m
air, and in consequen
spirit employed can b
tate of lead employed
be, at least, three tim
I have never seen any
absorbed in some case
pound as to that of th

Goulard water is u
cases already enumera
crumb of bread and
to phlegmons, painful

2. CERATUM PLUM
(Solution of Diacetate

---

[1] *Jou*
[2] *Lon*

℥j. Mix the melted wax with eight fluidounces of the oil; then remove them from the fire, and, when first they begin to thicken, gradually add the solution of diacetate of lead, and stir them constantly with a spatula until they cool; lastly, with these mix the camphor dissolved in the rest of the oil). —This is the *cerate of saturn* of M. Goulard, and is commonly called *Goulard's cerate.* If made with yellow wax it becomes white in blotches owing to the decoloration of the wax. If it be made with white wax it is more liable to become rancid. Does this depend on the spermaceti contained in the white wax of commerce? It is employed as a dressing to wounds and ulcers, for the purpose of allaying irritation and appeasing pain. With the same views it is also applied to excoriated surfaces, burns, scalds, blistered surfaces, and irritable cutaneous affections. Opium is sometimes advantageously combined with it.

3. CERATUM SAPONIS COMPOSITUM, L.; *Compound Soap Cerate.*—This contains subacetate of lead. It has been before described (see *ante,* p. 605).

137. EMPLASTRUM PLUMBI.—PLASTER OF LEAD.

HISTORY.—This compound was known to the ancients: both Pliny[1] and Celsus[2] give a formula for a plaster used by the Roman surgeons, which is almost identical with that for the officinal plaster of lead. It is commonly sold in the shops as *diachylon* or *diachylum* (from διά, *through,* and χῦλος, *juice*). [In the Edinburgh and Dublin Pharmacopœias it is called *Emplastrum Lithargyri.*—ED.]

PREPARATION.—The following are the directions of the British Colleges for its preparation:—

The *London College* orders of Oxide of Lead, rubbed to very fine powder, lb. vj.; Olive oil, *Cong.* j.; Water, Oij. Boil them together with a slow fire, constantly stirring, until the Oil and Oxide of Lead unite into the consistence of a plaster; but it will be proper to add a little boiling water, if nearly the whole of that which was used in the beginning should be evaporated before the end of the boiling.

The *Edinburgh College* orders of Litharge, in fine powder, ℥v.; Olive Oil, f℥xij.; Water, f℥iij. Mix them; boil and stir constantly till the oil and litharge unite, replacing the water if it evaporate too far.

The process of the *Dublin College* is subjoined:—Take of Litharge, in very fine powder, lb. v.; Olive Oil, *Cong.* j.; Water, Oij. Boil all the ingredients over a gentle fire, stirring constantly, until the oil and litharge acquire such consistence that they will solidify on cooling. Towards the close of the process a little boiling water should be added to supply the place of that which has disappeared. [Allowing for the different standards of weights the London and Dublin preparations are the same.[3]—ED.]

Olive oil is a compound of oleine (*oleate of glycerine*) and margarine

---

[1] *Hist. Nat.* xxiv. 53.

[2] *De Medicina,* lib. v. cap. xix.

[3] [Mr. W. Bartlett has suggested the following process as having been found by him successful for the preparation of a plaster which is not affected by hot climates.—To lbs. vij. of semivitrified oxide of lead, and lbs. x. of olive oil, one gallon of water is added at intervals during the process of boiling over a clear fire of charcoal or coke, no flame being allowed to come in contact with the vessel. It should be well stirred for eight hours without intermission, and then removed from the fire and allowed to get cool. (*Pharm. Journ.* 1849-50, p. 437.)—ED.]

(*margarate of gl*
some water, the ox
sets free glycerine,
oleate and margara
p. 599). The wat
moderates the heat
of lead.

MATERIALS.	
Water	
Olive Oil	Oleine.... Margarine
Oxide of Lead	Oxide of L Oxide of L

PROPERTIES.—It
or yellowish-white
fusing by heat. It
no taste, but a slight
Characteristics.–
flammable gas, and
close vessel, yields gl
of lead.

COMPOSITION.—L
margaric acid. Th
two compounds whi
probably basic salts.

EFFECTS AND USE
its adhesiveness and
tation. It is used
delicate skins. Spre
port and causing pr
treating them, and fo
it serves as a basis fo

1. EMPLASTRUM R
Plaster. (Resin, lb
plaster of lead, melt
Take of Resin in pow
lbij. To the litharge
and soap, and mix t
from those of the oth
by the Dublin College
ante, p. 606).—ED.]-
adhæsivum), and is k
the lips of wounds in
adhesive than lead pla
it occasionally causes
ulcers on Baynton's p

2. EMPLASTRUM S
plaster (see *ante*, p. 6

3. **UNGUENTUM PLUMBI COMPOSITUM,** L.; *Compound Ointment of Lead.* (Prepared Chalk, ℥vi.; Diluted Acetic Acid, f℥vj.; Plaster of Lead, lb. iij.; Olive Oil, f℥xviij. Melt the plaster in the oil over a slow fire, then first add the chalk and afterwards the acid, stirring constantly until they are cooled).—By the action of the acetic acid on the chalk, an acetate of lime is procured, and carbonic acid evolved, and the acetate of lime is then mixed with lead plaster and oil. This compound is an imitation of *Kirkland's neutral cerate,* which is used as a dressing to indolent ulcers. It is employed by Mr. Higginbottom[1], under the name of *neutral ointment,* as a defence for ulcers after the application of nitrate of silver.

138. Plumbi Saccharas.—Saccharate of Lead.

Formula $PbO,\overline{Sac}$. *Equivalent Weight* 208.

By the action of nitric acid on sugar, an acid has been obtained which is known by the various names of *oxalhydric, hydro-oxalic,* and *saccharic* acid. The formula for the anhydrous acid, according to the analysis of Heintz,[2] is $C^6H^4O^7=Sac$. Thaulow had previously given, for the hydrated acid, the formula $C^{12}H^5O^{11}+5HO$.

Saccharate of lead was first used in medicine by Dr. S. Elliott Hoskins.[3] This salt is best obtained by saturating an aqueous solution of saccharic acid with freshly precipitated and moist carbonate of lead, added in small successive portions: the first generally dissolve, but afterwards the saccharate falls in proportion as saturation ensues, in the form of a white powder, very sparingly soluble in boiling water. Saccharic acid exerts no greater action on phosphatic concretions than malic acid; and saccharate of lead is inert; but the acid saccharate of lead is an active decomponent of phosphatic calculi, though mild in its action on the living tissues. Dr. Hoskins prepared, what he calls *nitro-saccharate of lead,* by dissolving a portion of pulverised saccharate of lead in a sufficient quantity of cold dilute nitric acid (one acid to nineteen water). The solution was filtered and gradually evaporated, by which amber-coloured crystals in the form of regular hexagonal plates or prisms were obtained. These he calls the nitro-saccharate of lead.

A solution of nitro-saccharate of lead was prepared by moistening one grain of nitro-saccharate of lead with five drops of pure saccharic acid, and dissolving in a fluidounce of distilled water. The solution was bland without any astringency, though it possessed a slight acid reaction. It acted rapidly on phosphatic calculi; but was so mild in its influence on the urethral and conjunctival membranes as to be tolerated with perfect impunity. Injected into the bladder of sheep daily for several weeks, it excited no untoward symptoms. It was thrown daily, or every second day, into the bladder of an old gentleman who had long suffered from vesical affection, accompanied with alkaline urine, phosphatic sediment, and copious formation of ropy mucus. It was retained in the bladder for fifty minutes. The patient was much benefited by the practice.

In two cases in which calculi existed in the bladder it was injected without any injurious effect, and in one of the cases with positive comfort. These experiments shew that the solution which possesses active decomposing powers on phosphatic calculi out of the body, is neither irritating nor injurious when introduced under proper restrictions into the bladder. Farther experiments, however, demonstrative of its therapeutic value, are required.

139. Plumbi Tannas.—Tannate of Lead.

Plumbum scytodepsicum.[4]—Pure tannate of lead is obtained by adding tannic acid to a solution of acetate of lead: the precipitate is to be collected on a filter, and dried.

---

[1] *Essay on the Use of Nitrate of Silver,* 2d edit. p. 119.

[2] *Chem. Gaz.* vol. ii. p. 255, 1844; also, Brande's *Manual of Chemistry,* vol. ii. p. 1315, 1848.

[3] *Philosophical Transactions* for 1843, p. 7.

[4] *Scytodepsicus,* σκυτοδεψικός, *belonging to curriers;* from σκῦτος, *a hide,* especially *a tanned hide,* and δέψω, *to make supple: acidum scytodepsicum,* tannic acid.

pile, of which the rust is the negative pole, and the metallic iron the pole. The oxidation is accelerated by the presence of carbonic acid air. Rust usually contains ammonia. When iron is coated with preserve it from rusting, it is said to be *galvanized*. Iron and zinc elements of a voltaic pile, of which the iron is negative to the zinc.[1]

Considered with respect to its action on acids, iron is said to be *active* or *passive*. In general, nitric acid, of sp. gr. 1·35, acts power iron, and forms a solution of the nitrate of iron. Iron which underg change is said to be *active*. But various circumstances (such as im the metal in fuming nitric acid,) are capable of throwing the iron *passive* condition, in which it resists the action of acids.

It requires a very intense heat (=3300°, F., according to Daniell) it, and in the softened state, previous to melting, it is capable of being [*i. e.* two masses may be completely united by percussion.]

Characteristics.—Iron readily dissolves in diluted sulphuric acid, evolution of hydrogen gas. $Fe + HO,SO^3 = FeO,SO^3 + H$.

The solution of protosulphate of iron readily attracts oxygen from by which a portion of protoxide (FeO) is converted into sesquioxide (Fe^2O^3). Hydrosulphuret of ammonia (NH^3,HS) occasions a bla cipitate (FeS) when added to the solution. Caustic potash or ammon duces a whitish precipitate (FeO,HO), which becomes greenish, and ulti by exposure to the air, reddish-brown (Fe^2O^3,3HO). Ferrocyanide of sium causes a white, or bluish-white precipitate, which, by exposure to ultimately becomes blue. Ferridcyanide of potassium occasions a da precipitate, called Turnbull's blue. Binoxide of nitrogen communi greenish-brown colour to a solution of protosulphate of iron.

By boiling the solution of the protosulphate with a little nitric a obtain in solution persulphate of iron. This yields, with ferrocyanide of sium, a blue precipitate (Prussian blue); with ferridcyanide of potass deep green solution, but no precipitate; with sulphocyanide of potass red colour, owing to the formation of a soluble persulphocyanide ($2Fe,3CyS^2$); with meconic acid, a red coloured liquid ($Fe^2O^3,\overline{Mec}$) gallic or tannic acid, a purple or bluish-black precipitate; with succi ammonia, a light brown precipitate ($Fe^2O^3,2\overline{Suc}$); with benzoate of am a yellowish-brown precipitate ($Fe^2O^3,3\overline{Bz}$).

PHYSIOLOGICAL EFFECTS. α. **Of Metallic Iron.**—Iron is probably in only acts mechanically, so long as it retains its metallic form; but it oxidises in the alimentary canal, and thereby acquires medicinal pow *ante*, p. 193). As acids promote this chemical change, acid wines and assist in rendering the metal active, while alkalies and their carbonate an opposite effect. The oxidisement of the iron is attended with the tion of hydrogen gas, which gives rise to unpleasant eructations. If s be taken along with the iron, hydrosulphuric acid is developed. Lik ferruginous preparations generally, the internal employment of iron blackening of the stools, owing to the formation of the hydrated sulphu iron. The nature of the effects produced by oxide of iron formed i alimentary canal will be best examined hereafter under the head of ferruginous preparations. I may, however, remark here, that it is one of the few metals which by oxidisement is not rendered more or less poisonous.

---

[1] [The zinc corrodes, while the iron is preserved. The 4000 miles of Electric Telegra throughout this country are formed of zinced iron, the iron being thus coated and protected.

β. **Of the Ferruginous Compounds.** αα. *On Vegetables.*—Most of the compounds of iron do not appear to be hurtful to plants; at least, this is the case with the oxides.[1] The sulphate, however, is injurious to vegetation.

ββ. *On Animals.*—The effects of the ferruginous compounds on animals generally are similar to those on man. It is stated that in animals to which iron has been given for a considerable time, the spleen has been found smaller, harder, and denser. The liver is also said to have been affected in a similar manner, although in a somewhat slighter degree.

γγ. *On Man.*—The *local* effects of the sulphate, nitrate, and sesquichloride of iron are those of caustics and irritants, and these preparations accordingly rank amongst poisons. Most of the ferruginous preparations are astringent; that is, they constringe the parts with which they are in contact, and thereby diminish secretions and check sanguineous discharges. Thus, when swallowed, they repress the secretions and exhalation of the gastro-intestinal membrane, and thereby render the alvine evacuations more solid, and even occasion costiveness. The sulphate, nitrate, and sesquichloride of iron, are the most powerful of the ferruginous constringents. Administered in large quantities, or when the alimentary canal is in an irritable condition, all the compounds of iron are liable to excite heat, weight, and uneasiness at the præcordia, nausea, and even vomiting and sometimes purging. The oxides and the carbonate of iron are very mild topical agents.

Before the chalybeates can produce constitutional effects they must become absorbed. Under their use the blood frequently acquires a more scarlet colour, owing to an increase in the number of its colouring particles. Tiedemann and Gmelin[2] have detected iron in the serum of the blood of the portal and mesenteric veins of horses and dogs, to which they administered either the sulphate or chloride. Occasionally, too, iron has been found in the urine. Moreover, Menghini[3] asserts, that the quantity of iron in the blood of dogs may be increased by feeding them on substances mixed with this metal. Lastly, iron has been detected in the milk of animals to which the oxide had been administered.[4] The remote constitutional effects of chalybeates have been already described (see *ante*, p. 193). These preparations I have ventured to call *hæmatinics*, on account of their influence in augmenting the amount of hæmatin in the blood.

Unlike the antispasmodic spanæmics (arsenic, silver, copper, bismuth, and zinc), as well as lead and mercury, the chalybeates do not excite cramps, convulsions, paralysis, or narcotism, when administered in large doses or for a long period.

USES. — The general indications and contra-indications for the use of chalybeates, as well as a notice of the principal maladies in which they are employed, have been already given.

---

[1] De Candolle, *Phys. Vég.* 1837.

[2] *Vers. üb. d. Wege auf welch. Subst. aus d. Magen u. Darm.*

[3] Menghini, *De Ferrearum particularum progressu ad sanguinem*, in the *Comment. Acad. Bonon* t. ii. pt. iii. p. 475. (A notice of these is given by Bayle in his *Bibliothèque de Thérapeutique* t. iv. Paris, 1837).

[4] Chevallier and O. Henry, *Journ. de Chim. Méd.* sér. 2e, tome v. p. 200, 1839.

1. FERRUM IN
Filings, E.; *Fer*
Iron wire is used
of *iodide of iron*,
generally procured
being mixed with
employed to separ
imperfectly, as var
to procure them p
filings are employe
sulphate of iron
administered as a
and mercury. Th
ing formula explai
$CuO,SO^3+Fe=C$

Iron filings are
worm (see *ante*, p
cation, to repress
employed to produ
this purpose they a
dose of iron filing
electuary made wit

2. FERRI PULV
oxide of Iron, Zin
cient quantity. I
iron as will occupy
portion of the barr
in such a furnace a
means of a cork, in
while the other end
zinc and water, wit
fragments of caust
Matters being thus
bottle containing t
of hydrogen to exp
this object is con
containing the pero
and, when it is thu
gradually added to
pass through the oi
soon as the reductio
taken place when th
the water in which
the oil of vitriol, th
still continued); an
the air, its metallic
rately stopped bottl

[PROPERTIES.—
pure metallic iron:

When digested in the dilute acids, it is dissolved with strong effervescence, the gas evolved being hydrogen, nearly pure, or sometimes mixed with a trace of sulphuretted hydrogen, from the presence of a trace of sulphuret of iron in the compound. A protosalt of iron is formed by this reaction.

There is some trouble in obtaining iron in this finely reduced state. If the heat be insufficient, the reduction is incomplete: if carried too high, the particles of iron may become aggregated in masses.

PURITY.—The best tests of its purity are its entire solubility in acids with evolution of hydrogen, and the quantity of peroxide of iron which can be procured from a given weight of it: 10·3 grains of pure iron should yield 14·7 grains of peroxide; and 10·3 grains of a sample of *pulvis ferri*, prepared by Mr. Morson, was found by Dr. Gregory to yield 13·9 of peroxide. This preparation, which was as pure as it can be ordinarily obtained for medicinal use, was found by him to be thus constituted:—

Iron	97·3
Impurities	2·7
	100·0

The impurities consisted probably of carbon and sulphur, with traces of silica. These are commonly present in all iron that is met with in pharmacy.

ADULTERATIONS.—It is alleged that finely powdered magnetic oxide of iron has already been substituted and sold for this finely reduced iron.[1] Owing to its insolubility in the acid fluids of the alimentary canal, this compound would be quite inefficacious for the purpose for which *pulvis ferri* has been introduced into practice. The black or magnetic oxide of iron ($2FeO + Fe^2O^3$, or Fe^4O^5) is, as its name implies, black; it dissolves in acids without effervescence, or with only a slight escape of sulphuretted hydrogen. The two compounds resemble each other in being attracted by the magnet, but they yield unequal quantities of peroxide from equal weights. This will be obvious, as the magnetic oxide is already combined with oxygen. According to the authority already quoted, 10 grains of the black or magnetic oxide (Fe^4O^5) yield only 10·5 grains of peroxide. It is obvious, however, that mixtures may be made in all proportions: hence an excellent preparation of iron is likely to be brought into disrepute.

USES.—This preparation has been for some time known on the continent as *Quevenne's iron*. It was first introduced by MM. Quevenne and Miquelard under the name of *fer reduit*. It has been adopted in the Dublin Pharmacopœia, as well as in that of the United States, under the name of *pulvis ferri*. As a medicine it possesses the properties of other ferruginous preparations, acting like the protocarbonate of the metal. In consequence of its fine state of division it is far more soluble in the fluids of the alimentary canal than iron filings. It has no inky flavour, and is not liable to blacken the teeth.

As a chalybeate it is said to be objectionable, because it cannot be preserved from oxidation, and on account of the unpleasant eructations of hydrogen gas to which it gives rise. In reference to the first objection we may remark, that we have preserved iron perfectly bright, and without the least sign of oxidation, for many months, in a bottle filled with lime water and well stopped. This might be made the preservative medium until it was required for use.

---

[1] See *Pharmaceutical Journal*, Jan. and Feb. 1854, pp. 383, 387.

Dose and Admini
ten or twelve, in the
used this preparation
lowing ague, in dos
grains.—Ed.]

141. FERRI O

Formu

History.—It was
the *martial ethiops*
ferroso-ferricum of
of iron; and someti
Natural History
magnetic iron ore, t
It is found in Cornwa
Preparation.—D
burgh and Dublin Co
1. The *Edinburgh*

Take of Sulphate of
Nitric Acid, f℥iv.; Stro
half the sulphate in hal
nitric acid by degrees, b
Dissolve the rest of the
solutions; and immediat
same time briskly. Coll
the water is scarcely pre
perature not exceeding 1

The object of the fi
protoxide of iron int
adding nitric acid to
protoxide, while bino
of sulphuric acid is re
prevent a deposition
the sulphate of iron d
tional quantity of sul
sufficient for the pu
solution of protosul
hydrated protoxide a
washed with water un
dried at 180° it con
Pharmacopœia, and th
copœia.
2. The Dublin Col

Take of Sulphate of I
sufficient quantity. Con
eight ounces of the sulph

---

add the four remaining ounces of the sulphate of iron first dissolved in half a pint of distilled water. Mix well the resulting liquid with the solution of caustic potash, and, having boiled for five minutes in an iron vessel, collect the precipitate on a calicô filter, and wash it with boiling distilled water until the liquid which passes through ceases to give a precipitate when dropped into a solution of chloride of barium. Lastly, let the precipitate be dried by a steam or water heat, and, having been first reduced to a fine powder, let it be enclosed in a well-stopped bottle.

There are several other methods of procuring this compound. In the Paris Codex it is directed to be prepared by covering iron with water and exposing the mixture to the air: then, by elutriation, separating the black powder.

PROPERTIES.—*Magnetic iron ore*, FeO,Fe^2O^3, occurs earthy, compact, lamelliform, and crystallised in the form of the regular octohedron.

Scales of oxide of iron vary somewhat in their properties and composition. The *inner scales*, $6FeO,Fe^2O^3$, are blackish grey, porous, and brittle. The *outer scales*, $4FeO,Fe^2O^3$, are redder.

Hydrated black oxide of iron (*ferri oxydum nigrum*, Ph. Ed.) contains about seven per cent. of water. It is a greyish-black powder, with a velvety appearance, and is strongly magnetic. It dissolves in hydrochloric acid without effervescence. According to the Edinburgh Pharmacopœia its properties are as follows:—

> "Dark grayish-black: strongly attracted by the magnet: heat expels water from it: muriatic acid dissolves it entirely; and ammonia precipitates a black powder from this solution."—*Ph. Ed.*

COMPOSITION.—*Magnetic iron ore* has the following composition:—

	Atoms.	*Eq.Wt.*	*Per Ct.*	*Fuchs.*			*Atoms.*	*Eq.Wt.*	*Fuchs.*
Iron	3	84	72·414	71·91	or	Protoxide	1	36	30·88
Oxygen	4	32	27·586	28·09		Sesquioxide	1	80	68·40
Magnetic Iron Ore	1	116	100·000	100·00			1	116	99·28

Scales of oxide of iron, according to Mosander, have the following composition:—

	Outer Layer.		*Inner Layer.*	
	Atoms.	*Eq.Wt.*	*Atoms.*	*Eq.Wt.*
Protoxide of Iron	4	144	6	216
Sesquioxide of Iron	1	80	1	80
Scales of Iron	1	224	1	296

Hydrated black oxide of iron (*ferri oxydum nigrum*, Ph. Ed.), called by Wöhler[1] *æthiops martialis hydratum*, has the following composition:—

	Atoms.	*Eq.Wt.*	*PerCt.*			*Atoms.*	*Eq.Wt.*	*PerCt.*
Iron	3	84	67·2	or	Protoxide of Iron	1	36	28·8
Oxygen	4	32	25·6		Sesquioxide of Iron	1	80	64·0
Water	1	9	7·2		Water	1	9	7·2
Hydrated Black Oxide of Iron	1	125	100.0			1	125	100·0

PURITY.—Black oxide of iron should be readily soluble in hydrochloric acid, without effervescence; by which the absence of metallic iron is shown.

PHYSIOLOGICAL EFFECTS AND USES.—These are similar to those of the chalybeates in general, and which have been already described. It does not produce local irritation. It is a more valuable preparation than the sesquioxide, in consequence of being more readily soluble in the fluids of the stomach.

ADMINISTRATION.—Dose from grs. v. to ℈j. or more, twice or thrice daily.

---

[1] *Ann. d. Pharm.* Bd. xx. S. 56 (*Jahrbuch d. Pharmacie*, Bd. xxxvii. 1837).

142. FERRI S

HISTORY.—Geb
crocus martis. I
oxide of iron (*fer*
dum, D.) of some
NATURAL HISTO
iron, micaceous ir
(*red hæmatite*) : t
the second is foun
ochre is sesquioxi
chalk, is an argilla
iron. Hydrated s
subsequently.
PREPARATION.—
1. **By precipitati**

The *London College* o
Water, boiling, *Cong.*
rately, in three gallons
the powder may subsid
precipitated with wate
The *Edinburgh Col*
Boiling Water, Oss.;
add the cold water, an
its weight of water. C
water is but little affec
press, or over the vapo
The *Dublin College*
to the following effect :
an oven, on a few folds
transfer it to a covered

In the processes
sulphate of iron is
the products of the
protoxide of iron,
soda, which remains

MATERIALS.

1 eq. Carbonate Soda 53 {
1 eq. Sulphate Iron.. 76 {
129

By exposure to th
the protoxide of iron
protoxide, and there
disengaged. 2(FeO,
When prepared a
chocolate-brown, and

---

carbonate of the protoxide of iron. Manufacturers, however, usually calcine it in an iron pot, by which it acquires a brownish-red colour and is more saleable.

Sesquioxide of iron, as thus procured, is frequently termed *carbonate* or *subcarbonate of iron* (*ferri carbonas*, D.), or *precipitated carbonate of iron* (*ferri carbonas præcipitatus*).

2. **By calcining Sulphate of Iron.**

In this case the water and sulphuric acid of the crystallised sulphate of iron are evolved. The iron is peroxidised at the expense of a portion of the sulphuric acid, while some sulphurous acid is developed. Sesquioxide of iron prepared by this process is known in commerce as *colcothar*, *caput mortuum vitrioli*, *trip*, *brown-red*, *rouge*, and *crocus*. The scarlet parts are called *rouge*; the red, purple, or whitish parts, which have been exposed to the strongest heat, are termed *crocus*. *Purple brown* is the name given to the sesquioxide which has been exposed to an intense white heat. *Venetian red* is essentially sesquioxide of iron obtained by calcining sulphate of iron. It is, however, usually adulterated (with *reddle*?) to suit the prices of the market. The powder sold in the shops as *bole armeniack* is a mixture of pipe clay and Venetian red.

3. **From Rust of Iron.**

This formerly entered into the Dublin Pharmacopœia under the name of *Rubigo Ferri*. It was directed to be prepared from iron wire, on account of its purity. Rust of iron is usually reduced to an impalpable powder by levigation and elutriation, and is then made up into small conical loaves, like prepared chalk (*prepared rust of iron*.)

PROPERTIES.—The primary form of the crystals of native sesquioxide of iron is the rhombohedron. The artificial sesquioxide of the shops is a brownish-red powder: when it has been exposed to an intense heat, it has a purplish tint. It is odourless, insoluble in water, and not magnetic. Prepared according to the London Pharmacopœia, it has a styptic taste: when calcined, it is tasteless. When quite free from carbonate of iron, it dissolves in hydrochloric acid without effervescence.

Characteristics.—Its neutral hydrochloric solution affords a deep blue precipitate with the ferrocyanide of potassium, a purplish-black precipitate with tincture of nutgalls, a brownish-red precipitate with the alkalies, and a red colour with sulphocyanic or meconic acid.

COMPOSITION.—Sesquioxide of iron has the following composition:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Gay-Lussac.*	*Berzelius.*
Iron	2	56	70	70·27	69·22
Oxygen	3	24	30	29·73	30·78
Sesquioxide of Iron	1	80	100	100·00	100·00

PURITY.—If it should contain copper, its hydrochloric solution will deposit this metal on a bright rod of iron. After the sesquioxide has been thrown down by ammonia from the hydrochloric solution, the supernatant liquor should give no indications of containing any other metal in solution, and chloride of barium ought not to occasion any precipitate. Orfila[1] obtained

---

[1] *Journal de Chimie Méd.* t. vi. 2nde Série, p. 646.

traces of arsenic i
five hours with p
apparatus.

Dissolved totally b
precipitated by potas
sulphuric acid or the
"Entirely soluble i

PHYSIOLOGICAL
Its obvious effects
stools, and in larg
the stomach, and
astringency. The
are those produced
been before descri
USES.—It may
the ferruginous to
Mr. Benjamin Hut
gives complete, in
whatever is obtain
the patient fancied
mended it as a rem
ADMINISTRATION
grs. x. to ʒss. In
from ʒss. to ʒiij. or
tuary. To enable
aromatics.

EMPLASTRUM F
Frankincense, or
℥j.; Plaster of Lea
frankincense being
and mix. *L.* Litha
wax, ʒiij.; Red Oxi
and add the mixture
mix the whole thoro
Burgundy Pitch, ℥ij
the Burgundy pitch
the mixture consta
called *Emplastrum*
nical support and sl
ness of the joints.

143. FERRI SE
TUM.—H

HISTORY.—In the
and Berthold as an a

---

[1] *Cases of Tic Doulour*
[2] Poggendorff, *Annalen*

NATURAL HISTORY.—The hydrated sesquioxide of iron (*brown iron stone*) is met with in Scotland, and at Shotover Hill, Oxfordshire.

PREPARATION.—The Edinburgh Pharmacopœia gives the following directions for this preparation (*ferrugo*, E.):—

Take of Sulphate of Iron, ℥iv.; Sulphuric Acid (commercial), f℥iijss.; Nitric Acid (D. 1380), f℥ix.; Stronger Aqua Ammoniæ, f℥iijss.; Water, Oij. Dissolve the sulphate in the water, add the sulphuric acid, and boil the solution; add then the nitric acid in small portions, boiling the liquid for a minute or two after each addition, until it acquires a yellowish brown colour, and yields a precipitate of the same colour with ammonia. Filter; allow the liquid to cool; and add in a full stream the aqua ammoniæ, stirring the mixture briskly. Collect the precipitate on a calico filter; wash it with water till the washings cease to precipitate with nitrate of baryta; squeeze out the water as much as possible; and dry the precipitate at a temperature not exceeding 180°.

When this preparation is kept as an antidote for poisoning with arsenic, it is preferable to preserve it in the moist state, after being simply squeezed.

Under the name of *Ferri Peroxydum Hydratum* the Dublin Pharmacopœia contains the following directions for this preparation:—

Take of Sulphate of Iron, ℥viij.; Pure Sulphuric Acid, f℥vj.; Pure Nitric Acid, f℥ss.; Solution of Caustic Potash, Oij.; Distilled Water, ℥xij. To ten ounces of the water add the sulphuric acid, and in the mixture, with the aid of heat, dissolve the sulphate of iron. Mix the nitric acid with the remainder of the water, and, having added the diluted acid to the solution of sulphate of iron, concentrate by boiling until, upon the sudden disengagement of much gas, the liquid passes from a dark to a red colour. Let this be now poured into the solution of caustic potash, and when the mixture has been well stirred place it on a calico filter, and let the precipitate be washed with distilled water until the liquid which passes through, ceases to give a precipitate when dropped into a solution of chloride of barium. Lastly, enclose the precipitate, while in the pasty state, in a porcelain pot whose lid is made air-tight by a luting of lard, so as to prevent the loss of water by evaporation.

The protoxide of the sulphate is converted into sesquioxide by the oxygen of the nitric acid. The sesquioxide requires an additional quantity of sulphuric acid to form the neutral sulphate of the sesquioxide: $2(FeO,SO^3)+O+SO^3=Fe^2O^3,3SO^3$. On the addition of caustic ammonia, the hydrated sesquioxide of iron is precipitated, while sulphate of ammonia remains in solution. The oxide retains in combination with it some ammonia, but this does not prove injurious to its therapeutical use. If potash or soda be substituted for ammonia, we obtain, unless the alkali be in excess, a subsulphate of iron instead of the hydrated oxide of iron; and if we use excess of alkali, a portion of it combines with the oxide. Oxide which has been precipitated by potash has been found not to be equally efficacious as an antidote for arsenic to that obtained by ammonia.[1]

PROPERTIES.—Hydrated sesquioxde of iron has a deep reddish-brown colour. Prepared for use, as an antidote to arsenious acid, it should be in the form of a soft or gelatinous moist magma. Though it may be dried at ordinary temperatures without undergoing decomposition, yet in this moist state it more readily renders arsenious acid insoluble; and, therefore, to preserve it in this condition it should be kept under water in a stoppered bottle. If this hydrated sesquioxide (prepared by ammonia) be added in a considerable excess to a solution of arsenious acid, and well agitated, the filtered liquor

---

[1] See Bunsen's Memoir before quoted; also, Dr. Maclagan *On the Action of Hydrated Sesquioxide of Iron in Arsenic*, in the *Edinburgh Medical and Surgical Journal*, No. 144.

of the subarsenite is se
water, 20·50. Accord
sesquioxide and the a
protoxide of iron, 2Fe²

COMPOSITION.—I
portion of *ammonia*
by decantation, yiel
According to the s
imperial pints (1·7
troy grains (499·61
imperial pint contai
PHYSIOLOGICAL E
sesquioxide before m
USES.—Hydrated
dote in poisoning by
first to assert the a
were confirmed by th
Lesueur,[6] of Bouley,
the Committee (com
the Société de Méde
other hand, Mr. Bret
its antidotal powers.
tity of the hydrated
combines with the aci
hydrated sesquioxide

---

[1] "This proportion of tw
which has been indicated by
antidotal effects."
[2] *Journal de Chimie Méd*
[3] *Elements of Chemistry,*
[4] *Op. cit.*
[5] *Journ. de Chim. Méd.* t.
[6] *Ibid.* p. 45.
[7] *Ibid.* p. 46.
[8] *Ibid.* p. 393.
[9] Quoted by Dr. Maclagan
[10] *Journ. de. Chim. Méd.* t
[11] Quoted by Dr. T. R. Bec

But it appears from the experiments of Dr. A. Taylor that when the hydrated sesquioxide is mixed with arsenious acid in the form of powder, that little or no chemical effect is produced. Now as in most cases of arsenical poisoning the arsenious acid is taken in the form of powder, it follows that in such the hydrated sesquioxide would not act as a chemical antidote; though it would doubtless be serviceable as a mechanical antidote. In thirty-one[1] cases in which it was given, recovery took place in twenty-nine. In one of these nearly two drachms of arsenic had been taken.[2] In the two unsuccessful cases the antidote could not be retained on the stomach.

ADMINISTRATION.—When exhibited as an antidote in arsenical poisoning it must be administered in very large doses, in a freshly hydrated state. Dr. Maclagan says that twelve, Devergie, thirty-two, parts of the hydrated oxide are required for every part of arsenious acid swallowed. Dr. Beck recommends that it should be given in the quantity of a table-spoonful every five or ten minutes, or as often as the patient can swallow it. If hydrated sesquioxide be not at hand, let the common red oxide of iron be given with water as a substitute; for though not equally efficacious with the hydrated oxide, it appears to possess some antidotal power.[3]

144. FERRI CARBONAS.—CARBONATE OF IRON.

Formula FeO,CO². *Equivalent Weight* 58.

HISTORY.—This compound must not be confounded with the sesquioxide of iron, which is frequently termed carbonate of iron (see *ante*, p. 823).

NATURAL HISTORY.—It occurs native in the crystallised state, constituting the mineral called *spathose iron*. *Clay iron ore* is a native carbonate of iron. Carbonate of iron is also found in the *carbonated chalybeate waters*, in which it is held dissolved as proto-carbonate by carbonic acid.

PREPARATION.—It is prepared by adding a solution of an alkaline carbonate to a solution of protosalt (as the sulphate) of iron, the atmospheric air being carefully excluded. The hydrated carbonate of the protoxide of iron is precipitated. By exposure to the air, oxygen is absorbed and carbonic acid is evolved.[4]

Soubeiran[5] exposed this well-washed precipitate, in thin layers, to a moist atmosphere for three months: its composition was then found to be *sesquioxide* (quite free from protoxide) *of iron*, 71·4; *carbonic acid*, 8·3; and *water*, 20·0.

---

[1] Dr. T. R. Beck, *op. cit.* [In the last edition (1851) of his *Medical Jurisprudence*, ii. 553, Dr. Beck does not express himself so strongly on the efficacy of the proposed remedy as the above quotation would imply. He speaks of it not as a chemical antidote, but as an *aid* to other remedies. The thirty-one cases above referred to are mixed cases, scattered in the American and English medical journals. He speaks of these as only a selection of favourable cases; the unfavourable cases are not recorded.—ED.]

[2] *London Medical Gazette*, vol. xix. p. 177.

[3] See *Journ. de Chim. Méd.* t. v. 2de Sér. p. 305, *et seq.*

[4] [The Austrian Pharmaceutical Journal contains a paper in which it is stated that the white carbonate of iron precipitated from a solution of protochloride of iron, redissolved by the addition of dilute nitric acid, gives a colourless liquid, which may be kept without oxidation even in an open flask; and when evaporated yields a nearly colourless double salt, which deliquesces in a moist atmosphere, but is not oxidised. It is probable that this salt contains a protonitrate of iron, which has been observed by Berzelius to possess a certain degree of stability. (*Pharmaceutical Journal*, vol. xiii. p. 635.)—ED.]

[5] *Journ. de Pharmacie*, t. xvi. p. 524.

The *Dublin* is
of this compound

Take of Sulphate o
Distilled Water, Cong
being raised to the bo
vessel for six hours.
precipitate is to be dr
Finally, let it be dried
a well-stopped bottle.

PROPERTIES.—N
of its crystals is th
above directed, is a
at first greenish, t
dissolves in sulphur
dissolves in carbon
natural solutions of
Characteristics.
The solution posse
solutions.
COMPOSITION.—C

Protoxide of Iron
Carbonic Acid ..

Carbonate of Ir

PHYSIOLOGICAL E
ferruginous compou
the fluids of the sto
mild. Its uses are
before mentioned.

1. FERRI CARBO
E. D., *Saccharine*
Carbonate of Soda,
Dissolve the sulpha
the solutions togeth
may subside. The
precipitated carbona
in f℥ij. of water,
powder is dried. Ke
Carbonate of Soda, ℥
College orders of c
same proportions.]
the water; add the
filter, and immediat
water as possible, a
the sugar previously

---

[1] [Mr. Squire remarks,
"continued washing with
of decomposing the proto
unimpaired; therefore w

much above 120°, *E.* The formula of the Dublin College is as follows:—Take of Sulphuret of Iron, ℥viij.; Crystallised Carbonate of Soda of Commerce, ℥x.; Distilled Water, *cong.* ij.; Refined Sugar, in fine powder, ℥iv.—With the sulphate of iron, carbonate of soda, and water, prepare as directed in the formula for *Ferri Carbonas*, and immediately after the carbonate has been expressed, mix it with the refined sugar. Dry the mixture at a temperature not exceeding 212°, and, having reduced it to a fine powder, preserve it in a well-stopped bottle, *D.*)—Dr. Becker, of Mühlhausen, suggested this compound, which is now for the first time admitted into all the British pharmacopœias. His idea was carried out by Klauer:[1] and hence this preparation is known on the continent as Klauer's *ferrum carbonicum saccharatum*. The sugar checks, though it does not completely prevent, the further oxidation of the iron. This preparation is a greenish powder,[2] composed of *protoxide of iron, sugar,* and *carbonic acid,* with some *sesquioxide of iron.* Its characters are, according to the Edinburgh College, as follows:

Colour greyish-green; easily soluble in muriatic acid, with brisk effervescence.

It may be given in doses of from five to ten grains.

2. MISTURA FERRI COMPOSITA, L. E. D.; *Compound Mixture of Iron; Steel Mixture; Griffith's Mixture.* (Myrrh, powdered, ʒij.; Carbonate of Potash, ʒj.; Rose Water, f℥xviij.; Sulphate of Iron, powdered, ℈ijss.; Spirit of Nutmeg, f℥j.; Sugar, ʒij. Rub together the Myrrh with the Spirit of Nutmeg and the Carbonate of Potash; and to these, while rubbing, add first the Rose Water with the Sugar, then the sulphate of Iron. Put the mixture immediately into a proper glass vessel, and stop it, *L.*—The processes of the *Edinburgh* and *Dublin Colleges* are essentially the same: we give the Dublin formula:—Take of Myrrh, in powder, ʒj.; Pure Carbonate of Potash, ʒss; Essence of Nutmeg, fʒj.; Rose Water, f℥viii.; Refined Sugar, ʒj.; Sulphate of Iron, ʒss.)—This is a professed imitation of Dr. Griffith's celebrated antihectic or tonic mixture.[3]

In the preparation of it, double decomposition takes place: by the mutual reaction of carbonate of potash and sulphate of iron we obtain sulphate of potash, which remains in solution, and carbonate of protoxide of iron, which is precipitated. To prevent the latter attracting more oxygen, it is to be preserved in a well-stoppered bottle. The quantity of carbonate of potash directed to be used is almost twice as much as is required to decompose the quantity of sulphate of iron ordered to be employed. The excess combines with the myrrh, and forms a kind of saponaceous compound, which assists in suspending the carbonate of iron in the liquid. When first made, this mixture has a greenish colour, owing to the hydrated ferruginous carbonate; but by exposure to the air it becomes reddish, in consequence of the absorption of oxygen, by which sesquioxide of iron is formed, and carbonic acid evolved: hence it should only be prepared when required for use.

It is one of the most useful and efficacious ferruginous preparations,

---

[1] *Pharmaceutisches Central-Blatt für* 1836, S. 827; also, *Journ. de Pharmacie*, t. xxiii. p. 86.

[2] For some observations on its chemical properties, see a paper by A. Buchner, in the *Pharmaceutisches Central-Blatt für* 1837, S. 755.

[3] *Practical Observations on the Cure of Hectic and Slow Fevers, and the Pulmonary Consumption*, 1776.

which is owing to
absorbed. Its const
compounds in gene
and stimulant operat
carbonate must not b
is admissible in most
but it is especially s
hysterical affections.
phthisis and chronic
conditions of the gas
The *dose* of it is o
and acidulous salts,
or tannic acid, are in

3. MISTURA FER
Take of Peruvian Ba
coarse powder, ʒiij.
magnet, ℥ss.;—Dige
vessel, with as much
product, and then ad
of Orange Peel, fʒi
bottle.

4. PILULÆ FERRI
Pilulæ Ferri cum M
of Iron. (Myrrh,
Treacle, of each, ʒj.
added the sulphate o
vessel previously wa
orders of Saccharine
one part. Beat the
—Prepared accordin
analogous in compo
Double decompositio
ducts are sulphate of
ferred to the carbo
latter.[1] These pills,
use. The effects and
Ferri composita.—

5. FERRI SUPERC
nated chalybeates co
water by the aid of
waters (see *ante*, p
colourless, have a ch

---

[1] [Mr. Davenport assum
given in the form of a prot
subsequently take place.
of iron by decomposition of
wards powdered and mixed
iron with sulphate of soda.

bonic acid, attract atmospheric oxygen, and let fall a reddish precipitate of the hydrated sesquioxide of iron.

Artificial solutions of the carbonated chalybeates are prepared in various ways. A convenient extemporaneous solution is obtained by mixing intimately sulphate of iron and bicarbonate of soda, and dissolving them in a tumblerful of carbonic acid water (*bottle soda water*). One hundred and thirty-nine grains of crystallized sulphate of iron require eighty-three grains of *sodæ sesquicarbonas*, L. to yield fifty-eight grains of carbonate of iron. It is advisable, however, to employ an excess of the sesquicarbonate of soda. If 10 grs. of sulphate of iron, and 10 grs. of the sesquicarbonate of soda, *L.* be used, we shall obtain a solution of about 4 grains of carbonate of iron, 2½ grs. of sulphate of soda, and 5 grs. of sesquicarbonate of soda. The solution should be taken in a state of effervescence.

Another mode of preparing a solution of carbonate of iron is to add bicarbonate of soda to a solution of sulphate of iron acidulated by some acid, as sulphuric, tartaric, or citric acid.

[It is commonly considered by chemists that there is no definite chemical combination between peroxide of iron and carbonic acid, but it is stated by Mr. Dawson[1] that the precipitate obtained by adding carbonate of ammonia to sesquichloride of iron, washed with cold water, and subsequently dried over oil of vitriol, was found to have the composition represented in the annexed formula. $7Fe^2,3CO^2+18Aq$, or $3(Fe^2O^3CO^2)+4(Fe^2O^3,HO)+14Aq$.—ED.]

145. Ferri Phosphates.—Phosphates of Iron.

There are several compounds formed by the union of phosphoric acid with the oxides of iron. Of these, three have been employed in medicine.

1. **Ferri Phosphas**, Ph. U.S.; *Phosphate of Iron; Ferrum phosphoricum cæruleum; Ferrum phosphoricum oxydulatum cum oxydo ferri; Phosphas ferroso-ferricus; Ferrum oxydo-oxydulatum; Blue Phosphate of Iron.*—The United States Pharmacopœia directs it to be thus prepared:—"Take of Sulphate of Iron, ℥v.; Phosphate of Soda, ℥vj.; Water, Cong. j. Dissolve the sulphate of iron and phosphate of soda severally in four pints of the water; then mix the solutions, and set the mixture by that the powder may subside; lastly, having poured off the supernatant liquor, wash the phosphate of iron with hot water, and dry it with a gentle heat." By the mutual action of sulphate of the protoxide of iron and phosphate of soda, we obtain the tribasic phosphate of the protoxide of iron, which is precipitated, and sulphate of soda, with excess of sulphuric acid, is left in solution. $3(FeO,SO^3)+HO,2NaO,cPO^5=3FeO,cPO^5+2(NaO,SO^3)+HO,SO^3$.

The tribasic phosphate of the protoxide of iron ($3FeO,cPO^5$) is a white powder, which is insoluble in water; but is soluble in dilute acids, as well as in ammonia. By exposure to the air it absorbs oxygen, and acquires a blue colour. Its formula in this state is, according to Rammelsberg,[2] $2(3FeO,cPO^5+8HO)+(3Fe^2O^3,2cPO^5,8HO)$. But Wittstein[3] asserts that its constitution is inconstant; and that the proportion of protophosphate in it to that of perphosphate varies from 9:1 to 2:1. Wittstein says it is impossible to produce it by adding a solution of phosphate of soda to the solution of the mixed sulphates of iron.

The *Codex Medicamentarius Hamburgensis* directs that when phosphate of iron (*ferrum phosphoricum*) simply is ordered, without the addition of the word oxidated (*oxydatum*), this blue phosphate is to be employed. The same rule may be conveniently followed in England.

---

[1] *Ibid.* 1849-50, p. 260.

[2] *Annalen d. Chemie*, Bd. lvi. S. 210, 1845.

[3] Buchner's *Repertorium*, 2ter Reihe; Bd. xxxix; S. 145, 1845.

Its effects, uses, and doses are similar to those of the following preparation. It was employed by Mr. Carmichael[1] (who calls it the phosphate of iron) in the treatment of cancer. He administered it both externally and internally. But for internal use he preferred the suboxyphosphate of iron to this blue phosphate. Applied topically to cancerous ulcers it caused less pain than the suboxyphosphate. Dr. Venables[2] proposed this preparation in the treatment of diabetes. He speaks in the highest terms of its power to restrain the excessive secretion of urine, to reduce the bulimia, and to invigorate and increase the powers of digestion. Dr. Prout[3] has borne favourable testimony to its effect. It is, he says, an excellent remedy, and he is disposed to think very favourably of it.

2. Ferri Perphosphas; *Ferri Oxyphosphas; Ferri Sesquiphosphas; Perphosphate, Oxyphosphate, Sesquiphosphate*, or *White Phosphate of Iron; Ferrum phosphoricum album vel oxydatum; Phosphas ferricus.*—This salt is obtained by mixing a solution of phosphate of soda with a solution of a persalt of iron: white perphosphate of iron is precipitated, while a salt of soda remains in solution. The precipitate is a basic phosphate, which, when dried at from 122° F. to 140° F., consists, according to Wittstein, of Fe^2O^3,cPO^5+8HO; but when dried at 212°, its formula is Fe^2O^3,cPO^5+4HO, as given by Rammelsberg. The phosphate obtained by the action of caustic ammonia on a solution containing sesquioxide of iron and phosphoric acid is $3Fe^2O^3,2cPO^5+16HO$; but by repeated washing the proportion of oxide to acid is 2 to 1.

Perphosphate of iron is a white powder, insoluble in water, but soluble, by means of a gentle heat, in dilute nitric acid. It is unalterable in the air. Heated to redness it is deprived of water, and becomes brown. The perphosphate of iron was employed by Mr. Carmichael in the same way and for the same purposes as the preparation above mentioned. He calls it the *oxyphosphate of iron*, and says that the blue phosphate was frequently sold in shops for it. Under the name of "oxyphosphate of iron" Fuzet-Dupouget[4] has recently used in cancerous diseases the perphosphate mixed with some protophosphate. He says it is prepared by adding a solution of phosphate of soda to a solution of sulphate of iron which has been exposed to light and air until it has acquired the brown colour of Madeira wine. He employed it as a palliative to allay pain, to remove the unpleasant odour of the discharge, and to restrain the progress of the disease. He gave it internally, and applied to the part the filtered liquor (sulphate of soda!) from which the phosphate had been precipitated.

This, as well as the preceding preparation, may be given in doses of from two to ten grains in the form of powder, pill, or electuary. Externally they may be applied in the form of a dusting powder, (either alone or mixed with gum or sugar), in the form of paste, of lotion, and of ointment. Mr. Carmichael thinks that the best mode of using them is to blend them with water to the consistence of a thin paste, with which the surface of the ulcer should be covered. It may be employed also in the form of lotion prepared by diffusing the phosphate through water. An ointment (composed of ʒij. of phosphate to ℥j. of fat) has been used; but Mr. Carmichael found that this was a less efficacious method of employing the phosphate.

Liquor Ferri Superphosphatis; Solutio Ferri Oxydati in Acido Phosphorico; Liquor Schobeltii.—This is an aqueous solution of superphosphate of iron, which was employed by Schobelt in decayed teeth, and for the relief of toothache. It is a solution of the perphosphate in aqueous phosphoric acid. Lint, moistened with about twenty drops of the solution, is introduced into the cavity of the tooth.

3. Ferri Superphosphas; *Subperphosphate of Iron; Suboxyphosphate of Iron.*—This salt is prepared by boiling the perphosphate of iron with a solution of caustic potash. A brownish-red powder is obtained, whose composition, according to Rammelsberg, is $15Fe^2O^4, cPO^5$; but, according to Wittstein,[5] it consists essentially of sesquioxide of iron, with some phosphoric acid and potash. It is scarcely soluble in acids or in water. Mr.

---

[1] *An Essay on the Effects of Carbonate and other Preparations of Iron in Cancer*, pp. 35, 341-343, 1809.

[2] *A Practical Treatise on Diabetes*, pp. 70-71, 1825.

[3] *On the Nature and Treatment of Stomach and Urinary Diseases*, 3d edit. p. 48, 1840.

[4] Dierbach, *Die neuesten Entdeckungen in der Mat. Med.* Bd. ii. S. 1322, 1843; and Buchner's *Repert.* 2ter Reihe, Bd. ix. H. 3, S. 358, 1837.

[5] Buchner's *Repertorium*, 2ter Reihe, Bd. xli. S. 44, 1846.

Carmichael preferred this, for internal use, to the other phosphates. Applied to cancerous ulcers it excites a very severe smarting sensation. When sprinkled over the common earthworm, it kills the animal, he says, more rapidly than the other phosphates, or even than arsenious acid. The dose of it is from grs. ij. to grs. x. given in the form of pills.

[Dr. Routh[1] has employed a new preparation of iron, formed by adding as much phosphate of iron as metabasic phosphoric acid in a boiling state will take up, and allowing it to cool. Dr. Routh states that he has found this new salt to be far more efficacious and speedy in its curative action than any other preparation of iron, in some cases of anæmia and debility brought on by venereal and other excesses, over-study, or depressing diseases, in which there is a prevalence of nervous symptoms, and a large quantity of phosphates are voided by the urine. Dose, one to two grains three times a day.—ED.]

[**4. Syrup of Pyrophosphate of Iron.** By M. E. Soubeiran.[2]—Take of Persulphate of Iron, 55·4 grs.; Water, 924· grs. This is to be slowly dissolved, which sometimes occupies two or three days; but it is preferable to put it into a flask, and to dissolve it in a water bath. Then take of Crystallised Pyrophosphate of Soda, 462 grs.; Pure Water, ℥vij. ʒvj.; Distilled Peppermint Water, ℥iiss. This is to be dissolved cold, or at a gentle heat, and then to the cold solution is to be added the previously described solution of persulphate of iron. At the moment of admixture a precipitate is formed, which, however, is soon dissolved; the liquor is to be filtered, and one pound five ounces avoirdupois of fine white sugar added. Dissolve without heat in a glass vessel. The solution must be made without heat, or at least at a temperature not exceeding 122° F., as otherwise the syrup would assume the colour of wine dregs, and become very dark when heated at from 160° to 180° F.—ED.]

146. FERRI SULPHURETUM.—SULPHURET OF IRON.

Formula FeS. *Equivalent Weight* 44.

HISTORY.—This preparation was formerly called ***chalybs cum sulphure præparatus.***

NATURAL HISTORY.—In the mineral kingdom sulphur and iron are frequently met with in combination.

Magnetic pyrites, Fe^7S^8, occurs at Kongsberg, in Norway, at Andreasberg, in the Hartz, and at other places.

Sulphuret of iron, FeS, is found in small quantity in some meteoric stones. It is sometimes formed by the action of decomposing organic matter on solutions of sulphate of iron.[3]

Common or ***yellow iron pyrites***, usually called ***mundic***, is a bisulphuret of iron, FeS^2. It occurs in Cornwall and Derbyshire. ***White iron pyrites, radiated pyrites***, or ***cockscomb pyrites***, is also FeS^2, but differs from mundic in the shape of its crystal, its specific gravity, and its strong tendency to decompose on exposure to the air and to furnish an efflorescence of sulphate of iron. The radiated pyrites rolled amongst the shingles upon the sea-beach are popularly termed ***thunder-bolts.*** Iron pyrites (FeS^2) is used in the manufacture of oil of vitriol, and for the preparation of sulphate of iron.[4]

PREPARATION.—Directions for the preparation of sulphuret of iron are given in both the Edinburgh and Dublin Pharmacopœias.

The *Edinburgh College* states that "the best sulphuret of iron is made by heating an iron rod to a full white heat in a forge, and rubbing it with a roll of sulphur over a deep vessel filled with water, to receive the fused globules of sulphuret which form. An inferior sort, good enough, however, for pharmaceutic purposes, is obtained by heating one part of sublimed sulphur and three of iron filings in a crucible in a common fire till the mixture begins to glow, and then removing the crucible and covering it, until the action, which at first increases considerably, shall come to an end."

---

[1] *Med. Times*, vol. xxiii. p. 104.

[2] *Journal de Pharmacie*; and *Pharm. Journal*, April 1853, p. 499.

[3] Pepys, *Trans. of the Geological Society*, vol. i. p. 399.

[4] [The pyrites found in primitive districts generally contains much arsenic, in the form of arseniuret of iron; and this arsenic is, during the manufacture, transferred to the sulphuric acid.—ED.]

The *Dublin College* directs that rods of iron should be exposed to the strongest heat of a forge, until they become white hot, and, when taken from the fire, let them instantly be applied to sticks of sulphur, so that the melted sulphuret as it is formed may drop into a stone cistern filled with water, and be thus protected from oxidation. The water being poured off, let the product be separated from the sulphur, and, when dried, let it be enclosed in a well-stopped bottle.

The sulphur and iron enter into combination, and form sulphuret of iron FeS.

PROPERTIES.—The appearance of sulphuret of iron varies somewhat according to the mode of procuring it. If properly prepared it gives out abundance of sulphuretted hydrogen gas, when mixed with either diluted sulphuric or muriatic acid, while a ferruginous solution is obtained.

COMPOSITION.—Its composition is liable to some variation. The best is a protosulphuret of iron, and has the following composition:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Hatchett.*	*Bucholz and Gehlen.*
Iron	1	28	63·6	63·5	63·3
Sulphur	1	16	36·4	36·5	36·6
Sulphuret of Iron	1	44	100·0	100·0	100·0

Sometimes, however, a compound containing a larger proportion of sulphur is found.

PHYSIOLOGICAL EFFECTS AND USES.—Sulphuret of iron is principally employed for the preparation of sulphuretted hydrogen. Biett and Cazenave,[1] however, have employed it in the treatment of cutaneous maladies. The last-mentioned physician considers that it agrees with levigated iron in its effects on the system. It provokes eructations of sulphuretted hydrogen. In cutaneous maladies of a scrofulous character it proved a valuable alterative, and was more serviceable than iodine. It appeared to be less irritating, and less apt to excite suppuration in scrofulous swellings. Biett gave it in obstinate lichen agrius.

ADMINISTRATION.—The dose is from gr. iv. to gr. xij., taken in syrup, or in the form of pill.

FERRI SULPHURETUM HYDRATUM; *Hydrated Protosulphuret of Iron.*—The black mud and filth of privies, drains, ponds, and bogs, is due to to the presence of the hydrated sulphuret of iron formed by the action of decomposing sulphur compounds on ferruginous earths. Organic substances containing sulphur as well as sulphates, in contact with decomposing organic matters, furnish the sulphur. The fæces, after the use of chalybeates, owe their black colour to the same compound.

It is obtained by adding an alkaline sulphuret to a solution of protosulphate of iron in recently-boiled or distilled water. $FeO,SO^3+KS=KO,SO^3+FeS$. If hydrosulphuret of ammonia be used, the equation is as follows:—

---

[1] Bourchardat, *Nouveau Formulaire magistral*, p. 204, 3me éd. 1845.

$FeO,SO^3+NH^3,2HS=FeS+NH^3,SO^3+HS$. The precipitate should be washed with recently-distilled or boiled water. It is a black substance, insoluble in water. By exposure to the air it absorbs oxygen, and is converted into the sulphate of iron. $FeS+4OFeO,SO^3$. Hence it should be preserved in well-stoppered bottles filled with recently distilled or boiled water, in order to exclude atmospheric air.

Mialhe[1] has proposed this agent as an antidote for poisoning by corrosive sublimate, the products of the reaction between those substances being protochloride of iron and sulphuret of mercury. $FeS+HgCl=FeCl+HgS$. He says that a gargle containing this hydrated sulphuret will instantly remove the metallic taste caused by putting a minute quantity of corrosive sublimate into the mouth. Mialhe also asserts that this sulphuret will render inocuous the salts of tin, antimony, silver, and arsenious acid. Orfila[2] states, as the result of his experiments, that if taken *immediately* after the ingestion of the poison, the hydrated protosulphuret completely destroys the poisonous quality of corrosive sublimate; but that if not exhibited until ten or fifteen minutes after the poison has been swallowed, it is useless.

Bourchardat and Sandras[3] have proposed to substitute what they call the *hydrated persulphuret of iron* for the hydrated protosulphuret; and they propose to obtain it by adding an alkaline sulphuret to a solution of a persalt of iron.

147. FERRI SULPHAS.—SULPHATE OF IRON.

Formula FeO,SO^3. *Equivalent Weight* 76.

HISTORY.—Sulphate of iron is one of the substances which Pliny[4] termed *chalcanthum*. This is evident from the circumstance of his statement, that the Romans called it *atramentum sutorium*, or *shoemaker's black*. It is frequently termed *copperas*, and in consequence has been sometimes confounded with the salts of copper:[5] *green vitriol* (*vitriolum viride*), *vitriol of mars* (*vitriolum martis vel vitriolum martiale*), *salt of mars* (*sal martis*), *and vitriolated iron* (*ferrum vitriolatum*), are other names by which it is known.

NATURAL HISTORY.—This salt is found native associated with iron pyrites, by the decomposition of which it is formed; and it occurs in the waters of several mines. It is rarely met with native in the crystallised state. It occurs, however, in the Rammelsberg mine, near Goslar; at Schwartzenburg, in Saxony; in the aluminous shale[6] at Hurlet, near Paisley; and in New England.

Sulphate of the protoxide of iron is found in some of the sulphated chalybeate mineral waters; as those of the Selken-brunnen at Alexisbad, of Mscheno in Bohemia, and of Buckowina in Silesia.

PREPARATION.—Sulphate of the protoxide of iron is prepared by dissolving clean unoxidised iron in diluted sulphuric acid.

---

[1] Mialhe, *Traité de l'Art de Formuler*, p. 110, 1845.

[2] *Traité de Toxicologie*, t. i. p. 718, 1843.

[3] *Bulletin de Thérapeutique*, Août 1843.

[4] *Hist. Nat.* xxxiv. 32.

[5] Dr. Cummin, *Lond. Med. Gaz.* xix. 40.

[6] According to Dr. Thomson (*Outlines of Mineralogy*, vol. i. p. 472, 1836), the sulphate found at Hurlet and Campsie was an *alumina-sulphate of iron*.

The *London College*
f℥j ; Iron, drawn int
these the Sulphate an
is dissolved. Strain t
Dry them.

The *Edinburgh Coll*
transparent green crys
water, acidulated with
Preserve the crystals i

The *Dublin College*
Vitriol of Commerce,
a porcelain capsule, ad
ceased, boil for ten mi
which, after the lapse
let them be dried upon
a well-stopped bottle.

Ferri Sulphus Granu
Oil of Vitriol of Com
the water on the iron
disengagement of gas
into a vessel containin
order that the salt may
decantation and drainin
with the remainder of
between folds of filterin
a glass bell over a com
in a well-stopped bottl

In this process on
combines with an equ
The equivalent of pr
acid to form an equi

MATERIALS.

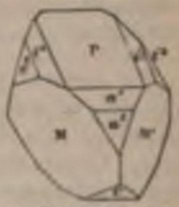
1 eq. Water........ 9 { 1
{ 1
1 eq. Iron........... 28 . .
1 eq. Sulphuric Acid 40 —
77

The *common gree*
shops, (*ferri sulph*
moistened iron pyrit
some places the ore i
or by manual labou
the products are prot
sulphuric acid forme
iron, the excess is sa
with the pyrites, or b
rate it, the equation
$+Al^2O^3,3SO^3$. The
large vessels lined wi
sulphate of alumina r
by the addition of sul
saturate the excess
$FeS^2+Fe+8O=2($

PROPERTIES.—Sul

pale bluish-green crystals, the form of which is the oblique rhombic prism. Their sp. gr. is 1·82. They have an acid, styptic taste, and redden litmus. When heated to 212° F., they give out 6 equivalents of water, and at a higher temperature lose their remaining equivalent of water. In the anhydrous state the salt is white, pulverulent, and astringent.

FIG. 142.



Crystal of Sulphate of Iron.

When the anhydrous salt is heated to redness, it is resolved into sesquioxide of iron, sulphurous acid, and anhydrous sulphuric acid; the two latter are volatilised. $2(FeO,SO^3) = Fe^2O^3 + SO^3 + SO^2$.

Sulphate of iron which is quite devoid of the sulphate of the sesquioxide, and which has been crystallised from perfectly neutral liquors, has a greenish-blue tint like that of the beryl. In commerce there are three varieties of sulphate of iron. The first is blue, with a slight tint of green, and has been obtained by crystallising it from acid liquors. The second is pale green, and has been formed in neutral liquors. The third is of an emerald-green colour, and has been produced in liquors which contain a considerable quantity of the sulphate of the sesquioxide (Pelouze and Fremy). By exposure to the air, the crystals of sulphate of iron absorb oxygen, become greener, then slightly efflorescent and somewhat opake, and ultimately acquire a yellow or ochry covering of the basic sulphate of the sesquioxide, $2(Fe^2O^3),SO^3$.

Crystallised sulphate of iron is soluble in water, but insoluble in alcohol. It requires two parts of cold, and three-fourths of its weight of boiling water, to dissolve it. The solution has a bluish-green colour, but by exposure to the air it attracts oxygen, becomes deep green, and deposits a basic sulphate of the sesquioxide, $2(Fe^2O^3),SO^3$. The liquor retains in solution a salt whose base is the deutoxide or magnetic oxide, FeO,Fe^2O^3. By the prolonged action of air on the solution, the colour becomes reddish-yellow, and the sulphate is entirely converted into the neutral sulphate of the sesquioxide ($Fe^2O^3,3SO^3$) and the basic sulphate, $2(Fe^2O^3),SO^3$.

[Wittstein gives the following formula for the precipitate produced by exposure of a solution of one part of the salt in four of water during four months in a slightly covered vessel.[1] $2FeO^3 + 3SO^3 + 8HO$.—ED.]

Characteristics.—It is known to be a sulphate by a solution of a barytic salt, and it possesses the characters of a protosalt of iron which have been already described.

The remarkable effect of binoxide of nitrogen on its solution has been already pointed out.

COMPOSITION.—The composition of this salt is as follows:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Berzelius.*	*Thomson.*
Protoxide of Iron	1	36	25·9	25·7	26·7
Sulphuric Acid	1	40	28·8	28·9	28·3
Water	7	63	45·3	45·4	45·0
Crystallised Sulphate of the Protoxide of Iron	1	139	100·0	100·0	100·0

PURITY.—The sulphate of iron of the shops almost invariably contains traces of the sulphate of the sesquioxide. This may be known by the yellowish-

---

[1] *Pharmaceutical Journal*, 1849-50, p. 38.

fixed residuum. I
mentioned.

PHYSIOLOGICAL
the sterility of a so

β. On Animals
iron given to a dog
a rabbit,—and tha
produced no effect
fatal to a dog when
obtained similar re
affection of the sto
animals fed with it

γ. On Man.—T
employed in a conc
its chemical action
remote effects of su
compounds, which l

Swallowed *in sm*
intestinal mucous
secreted or exhaled :
the stools like other
on the system as a t
medicinal doses it
of the stomach, an
especially the case i
it operates as an i
ounce of it in beer,
vomiting, and purgi
cured her.[6] A case
flexors of the hands

1
2
3
4
5

who had been engaged in picking the crystals of the sulphate from their mother liquor.

USES.—Sulphate of iron is to be preferred to other ferruginous compounds in cases in which there is great relaxation of the solid parts, with immoderate discharges. When the long-continued use of ferruginous compounds is required, it is less adapted for administration than some other preparations of iron, on account of its local action on the alimentary canal. It is employed in lump, powder, or solution, as a styptic, to check hemorrhage from numerous small vessels. A solution of it is applied to ulcerated surfaces and to mucous membranes to diminish profuse discharges, as in chronic ophthalmia, leucorrhœa, and gleet. Mr. Vincent used it in prolapsus ani. A solution of three drachms of the sulphate in five ounces of water has been used by Velpeau to repress erysipelas.

Internally, it is administered in passive hemorrhages, on account of its supposed astringent influence over the system generally; also in immoderate secretion and exhalation—as in humid asthma, chronic mucous catarrh, old dysenteric affections, colliquative sweating, diabetes, leucorrhœa, and gleet. In intermittents it has been employed as a tonic. It has also been found serviceable against tape-worm. Its other uses are the same as the ferruginous compounds before mentioned.

ADMINISTRATION.—The dose of it is from one to five grains in the form of pill. If given in solution, the water should be recently boiled, to expel the atmospheric air dissolved in it, the oxygen of which converts this salt into a persulphate. A very agreeable method of exhibiting sulphate of iron is in solution in carbonic acid water. Mr. Webb prepared it for me of three strengths: one containing three grains, a second six grains, a third nine grains of the crystallised sulphate to each bottle of carbonic acid water (bottle soda water).

For local purposes, solutions of it are employed of various strengths, according to circumstances. In chronic ophthalmia, we may use one or two grains to an ounce of water; as an injection in gleet, from four to ten grains. It has been used to disinfect night soil:[1] the products are sulphate of ammonia and hydrated sulphuret of iron.

1. FERRI SULPHAS EXSICCATUM, E.; *Ferri Sulphas Siccatum*, D.; *Dried Sulphate of Iron*. (Expose any convenient quantity of Sulphate of Iron to a moderate heat in a porcelain or earthenware vessel, not glazed with lead, till it is converted into a dry greyish-white mass, which is to be reduced to powder, *E.*) Take of Granulated Sulphate of Iron, any convenient quantity. Expose the salt in a porcelain capsule to an oven heat not exceeding 400°, until aqueous vapours cease to be given off, and having then reduced it to a fine powder, preserve it in a well-stopped bottle, *D.*)—By exposure to a moderate heat, the crystals lose $\frac{6}{7}$ths of their water of crystallisation; so that 85 grains of dried sulphate are equivalent to 139 grains of the crystallised sulphate, or 3 grains are equal to $4\frac{9}{10}$ grains of the crystals. The dried sulphate is used in the following preparation.

2. PILULÆ FERRI SULPHATIS, E.; *Pills of Sulphate of Iron*. (Dried Sulphate of Iron, *two parts*; Extract of Taraxacum, *five parts*; Conserve

---

[1] *Comptes-Rendus*, xix. 114.

the sesquioxide of iron
vitriol-ochre. Persulp
by means of nitric a
persulphate (Fe^2O^3,2S
equivalent of sulphuri
$Fe^2O^3,2SO^3+SO^3=Fe$
persulphuret of iron.

In 1842, Mr. Tyson'
sesquioxide of iron, wh
by Sylvester, about for
practitioners in Derbys
phate of Iron, ℥ij. or ℥i
the sulphate for a quart
paper. The dose of th
quassia, or in water.

Persulphate of iron
pernitrate and perchlori
on this property depend
of a tonic and hæmatini
other persalts of iron.
magnesia as an artificia
pills are composed of "s
table matter, probably g
however, that they are
mixture of protosulphat

149. FERRI S

F

History.—This ch
accurately described b
perchloride of iron, a

Natural History.
called *pyrosmalite.*
FeCl; as those of Ale

Preparation.—Fo

---

[1] *Pha*
[2] [illegible]

by dissolving sesquioxide of iron in hydrochloric acid. $Fe^2O^3 + 3HCl = Fe^2Cl^3 + 3HO$. By evaporation, the hydrated sesquichloride is obtained in a crystalline form.

PROPERTIES.—Sesquichloride of iron is a volatile solid. It deliquesces in the air, and forms the liquid commonly called *oil of iron* (*oleum martis*). The sesquichloride is soluble in water, alcohol, and ether. The ethereal solution, by exposure to solar light, is decolourised, and lets fall the protochloride of iron ($FeCl$). The aqueous solution deposits the brown pulverulent oxichloride, $Fe^2Cl^3,6Fe^2O^3,9HO$.

Characteristics.—It is known to be a persalt of iron by the tests for this class of salts; a chloride, by the tests for the chlorides.

COMPOSITION.—The anhydrous sesquichloride has the following composition:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*J. Davy.*
Iron	2	56·	34·46	35·1
Chlorine	3	106·5	65·54	64·9
Sesquichloride of Iron	1	162·5	100·00	100·0

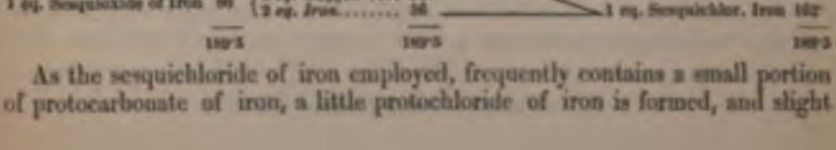
Ellerman's disinfecting fluid is essentially a solution of a persalt of iron. It is usually a mixture of a solution of sesquichloride of iron (made by dissolving the residue of the combustion of iron pyrites in hydrochloric acid) and of an impure solution of the persalt of iron. To this is commonly added the refuse solution of chloride of manganese resulting from the manufacture of chlorine. It decomposes the hydrosulphurets, and destroys the offensive odour of night soil and other kinds of decomposing organic matter.

TINCTURA FERRI SESQUICHLORIDI, L. D.; *Tincture of Sesquichloride of Iron; Ferri Muriatis Tinctura*, E.; *Tincture of the Muriate of Iron.*—All the British Colleges give directions for its preparation.

The *London* and *Edinburgh Colleges* order of Sesquioxide of Iron, ℥vj.; Hydrochloric Acid, Oj.; Rectified Spirit, Oiij. Mix the Sesquioxide of Iron with the Acid, and digest on a sand-bath, frequently shaking. Lastly, add the Spirit to the liquid when cold, and strain.

The *Dublin College* orders of Iron Wire, ℥viij.; Pure Muriatic Acid, Oij.; Rectified Spirit, Oiss.; Pure Nitric Acid, ℥xviij.; Distilled Water, Oj. Dilute the muriatic acid with the water, and, having poured the mixture on the iron, apply a gentle heat until the metal is dissolved. Next add the nitric acid in successive portions, and then evaporate at a gentle heat until the solution is reduced to one pint. Finally, mix this in a bottle with the spirit, and after the mixture has stood for twelve hours, draw off the clear tincture. The specific gravity of this tincture is 1·237.

By digestion in hydrochloric acid the sesquioxide becomes the sesquichloride of iron, while water is formed. In the *Dublin* process chlorine is set free and combines directly with the iron, the hydrogen being taken by part of the oxygen of the nitric acid.


MATERIAL.
COMPOSITION.
PRODUCTS.
3 eq. Hydrochloric Acid 109·5
3 eq. Hydrogen .. 3
3 eq. Chlorine .... 106·5
3 eq. Water 27
1 eq. Sesquioxide of Iron 80
3 eq. Oxygen 24
2 eq. Iron........ 56
1 eq. Sesquichlor. Iron 162
189·5
189·5
189·5

As the sesquichloride of iron employed, frequently contains a small portion of protocarbonate of iron, a little protochloride of iron is formed, and slight

effervescence, owing to the escape of carbonic acid, takes place.
chlorides of iron are soluble in water as well as in spirit.

This tincture is of a reddish-brown colour, and stains white pape
It has a sour styptic taste, and an odour of hydrochloric ether, from
would appear that a mutual reaction takes place between the hydrochl
and the alcohol. It reacts on vegetable colours as an acid. "Its
about 0·992, and a fluid ounce yields, when decomposed by potash, n
grains of sesquioxide of iron."[1]

Characteristics.—Its reaction on vegetable colours, its inflammab
remarkable odour, and its reactions as a persalt of iron and as a chlor
supra), are properties sufficient to characterise it. When nearly ne
forms a brown semitransparent jelly with a strong solution of gum ar

The specific gravity of this solution is ·992. A fluid ounce of it when mi
potash produces a precipitate of sesquioxide of iron weighing about 30 grains.—

Composition.—This tincture consists of *rectified spirit,* a small po
hydrochloric ether, hydrochloric acid, sesquichloride of iron, a
quently a small portion of *protochloride of iron.* Unless excess of
chloric acid be present, sesquioxide (oxichloride?) of iron is thrown
when the tincture is exposed to the air.

Purity and Strength.—The commercial tincture of sesquichloride
varies in its strength, owing to the varying density of the hydrochlor
employed; and perhaps also to the condition of the sesquioxide; for
this has been calcined it is less readily soluble in acids. Moreover, a
spirit is frequently substituted for rectified spirit. These differences c
be discovered by examining the colour and specific gravity of the tinct
well as the quantity of oxide which it yields.

Physiological Effects.—Tincture of sesquichloride of iron is, in i
action, one of the most powerful of the preparations of iron. It act
energetic astringent and styptic, and in large doses as an irritant. The
quantity of free hydrochloric acid which the tincture of the shops freq
contains, contributes to increase its irritant properties; and in Dr. Chris
Treatise on Poisons is a brief notice of a case in which an ounce and
of this tincture was swallowed, and death occurred in about six week
symptoms during life, and the appearances after death, being those ind
of inflammation of the alimentary canal. When swallowed in large me
doses it readily disorders the stomach. The general or constitutional
of this preparation agree with those of other ferruginous compound
appears to possess, in addition, powerfully diuretic properties. Ind
would seem to exercise some specific influence over the whole of the u
apparatus; for, on no other supposition can we explain the remarkable
which it sometimes produces in affections of the kidneys, bladder, urethr
even the prostate gland. It colours the fæces black, and usually const
the bowels.

Uses.—It is sometimes, though not frequently, used as a topical
Thus it is applied as a *caustic* to venereal warts, and to spongy granula
As an *astringent* it is sometimes employed as a local application to
attended with a copious discharge; or as a *styptic* to stop hemorrhage

---

[1] Mr. R. Phillips, *Transl. of the Lond. Pharm.*

numerous small vessels. [In the form of a weak solution, the perchloride has been employed in surgery for the purpose of effecting the cure of aneurism without operation. A recent case in which a cure was thus effected by M. Lobert[1], has been lately brought before the French Academy. A small trocar was introduced into the sac: the blade was then withdrawn, and six drops of a solution of perchloride of iron were injected through the canula into the interior of the sac. The injection was repeated, and some severe local and constitutional symptoms followed; nevertheless the sac was ultimately converted to a solid hard tumour. The severe symptoms following the injection were chiefly due to arteritis excited by the irritating action of the perchloride on the walls of the injured vessel. Perchloride of iron in M. Jobert's opinion should be restricted in its employment chiefly to the treatment of traumatic aneurisms, in sacs lately formed and free from inflammation. He regards it as a dangerous method of treatment when the aneurismal sac is inflamed, or when changes of any duration have rendered its walls degenerate and diseased. An Italian surgeon, M. Villardebo,[2] in 1831, suggested the plan of injecting the sacs of aneurisms with alcohol or some other agent capable of causing coagulation of the blood. M. Leroy d'Etioles, in 1844, published the results of his experiments upon horses with injections of alcohol. M. Pravaz had previously employed the tincture of perchloride of iron for the same purpose. The suitability of this preparation for styptic purposes has been amply confirmed by the subsequent observations of MM. Lallemand, Niepce, Marjolin, Guersant, Lenoir, Velpeau, and others. As applied to the treatment of aneurismal tumours it has generally been found by French surgeons to be very successful. It frequently causes immediate coagulation of the contents of an aneurismal sac. This is followed by inflammation and suppuration: a small puncture gives exit to a purulent serosity, and within a short period an eschar is cast off, while the tumour itself contracts to the size of a small nut. This plan of treatment is more especially adapted to aneurisms of those vessels the trunks of which are not accessible for ligature. The following are the principal phenomena observed on the injection of the perchloride into an artery. *a. Primary.*—1. The formation of primary and secondary clots. 2. The infiltration of plastic-lymph into the sheath of the artery, and adhesion of the clots. *β. Secondary.*—1. The elimination of the disorganised parts. 2. Hypertrophy of the middle coats. 3. The encysting of the clots. 4. The disappearance of the secondary clots and plastic formations. 5. Occlusion of the artery. As this liquid is a powerful irritant, there is necessarily some risk attending its use in the treatment of aneurisms. In one instance death took place from phlebitis after the use of this injection.[4]

M. Malgaigne has lately brought before the Academy of Medicine of Paris, a series of cases which tend to show that the above injections are not only very often ineffectual, but that they are fraught with much danger, and have caused death in one case. M. Velpeau and M. Roux do not, however, join M. Malgaigne in his condemnation of the use of the perchloride, and think that further trials should be made, especially as regards erectile tumours. The in-

---

[1] See *Medical Times and Gazette*, October 7, 1854, p. 377.
[2] *Bulletin Thérap.* t. xliv. p. 462.
[3] *Gazette des Hôpitaux*, May 2. 1854.
[4] *Bulletin Thérapeutique*, tome xlv. p. 269.

ligament. M. Sou
turing the sac, the
yields one drop at e
became harder and s
the tumour was con
pulsations returned i
drops were injected
were now alarming,-
and phlegmonous i
maintained on the
The pulsations havin
the vessel tied, and t

2. The second case
artery, as a consequen
of a few drops of th
the contrary the tum
terated by ligature a

M. Petrequin, of
aneurismal sac with
able owing to the fluid

Internally it may b
other ferruginous co
mentioned. It has b
Bell[2] has employed thi
The bowels are first t
cases, in doses of fro
only local application
be given in doses of
of the urino-genital o
retention of urine, a
beneficial. It should
benefit is obtained, whi
It has been used with

---

[1] L
[2] E
[3]

by Drs. Thomas, Eberle, and Francis;[1] and by Dr. Davy.[2] However, Mr. Lawrence,[3] alluding to Mr. Cline's recommendation of it, observes, "I believe general experience has not led others to place any very great confidence in the use of this remedy." In gleet and leucorrhœa it is sometimes serviceable. I have found it occasionally successful, when given in conjunction with the tincture of cantharides, in the latter stage of gonorrhœa, after a variety of other remedies had failed. In passive hemorrhage from the kidneys, uterus, and bladder, it is likewise employed with benefit.

ADMINISTRATION.—The dose of it is from ten to thirty minims, gradually increased to one or two drachms, and taken in some mild diluent.

ANTIDOTES.—In a case of poisoning by it, the treatment should be the same as for the mineral acids.

150. FERRI AMMONIO-CHLORIDUM.—AMMONIO-CHLORIDE OF IRON.

HISTORY.—This substance, which was known to Basil Valentine, has had various appellations; such as *flores salis ammoniaci martiales*, *ferrum ammoniacale*, or *ferrum ammoniatum*.

PREPARATION.—In the London Pharmacopœia it is directed to be thus prepared:—

Take of Sesquioxide of Iron, ℥iij.; Hydrochloric Acid, Oss.; Hydrochlorate of Ammonia, lb. iss.; Distilled Water, Oiij. Mix the sesquioxide of iron with the hydrochloric acid in a proper vessel, and digest them in a sand-bath for two hours; afterwards add the hydrochlorate of ammonia first dissolved in the distilled water; strain and evaporate the liquor. Lastly, rub what remains to powder.

By the mutual reaction of sesquioxide of iron and hydrochloric acid we obtain sesquichloride of iron and water. A small portion of protochloride of iron will be produced if any carbonate of the protoxide of iron be mixed with the sesquioxide. By evaporating the solution thus procured with a solution of hydrochlorate of ammonia, we obtain a mixture of these bodies. There is no reason to believe that any chemical combination takes place.

PROPERTIES.—It is met with in the shops in the form of reddish orange-coloured crystalline grains, having a feeble odour and a styptic saline taste. It is deliquescent, and is soluble in both water and alcohol.

Characteristics.—Rubbed with quicklime or caustic potash, ammonia is evolved. Its solution affords chloride of silver when mixed with the nitrate of silver. It reacts as a persalt of iron.

COMPOSITION.—It is a mechanical mixture of hydrochlorate of ammonia and sesquichloride of iron, in the following proportions:—

	Per Cent.
Sesquichloride of Iron	15
Hydrochlorate of Ammonia	85
Ferri Ammonio-Chloridum, *Ph. L.*	100

It yields about 7 per cent. of sesquioxide of iron when decomposed by an

---

[1] Eberle's *Treat. on Mat. Med.* ii. 270, 2d ed.

[2] Paris's *Pharmacologia*, ii. 478, 6th ed.

[3] *Lond. Med. Gaz.* vi. 845.

alkali (Mr. R. Phillip
drochlorate of ammon
ride of iron and hydr

PURITY.—The *Lon*

Pulverulent, of an ora
either solution evolves a
sesquioxide of iron.

PHYSIOLOGICAL E
nous preparations; b
present, it is a comp
ammonia which it co

USES.—It has bee
amenorrhœa, and oth
ployed.

ADMINISTRATION.—
twelve or more grains

TINCTURA FERRI
Chloride of Iron.—[
remarks on the form
macopœias for 1836

For 183

Take of ammonio-chl
Proof Spirit, Oj. Diss
chloride of Iron in the s

Mr. Phillips states, in
ounce yielded by decom
sesquioxide of iron.

It is obvious, from
authority of Mr. Phill
of the preparation wa
prepared according t
made according to th
is as follows:—In ord
of 1836, the College
half a pint of proof
for the four ounces of
error, the word *half*
authority for this stat
of the strength intend
error should be officia
erratum on a fly-le
that this preparation

---

151. FERRI IODIDUM.—IODIDE OF IRON.

Formula FeI. *Equivalent Weight* 154.

HISTORY.—We are indebted to Dr. A. T. Thomson for the introduction of this substance into medicine.[1] To distinguish it from other compounds of iodine and iron, it is sometimes termed *protiodide of iron*. Other names for it are *ioduret*, *hydriodate*, or *iodohydrale of iron*.

PREPARATION.—Directions for the preparation of this compound are given both by the Edinburgh and Dublin Colleges.

The *London College* gives no formula for its preparation.

The *Edinburgh College* orders any convenient quantity of Iodine, Iron-wire, and Distilled Water in the proportions for making solution of Iodide of Iron [see *Ferri Iodidi Syrupus*]. Proceed as directed for that process; but before filtering the solution concentrate it to one-sixth of its volume, without removing the excess of iron-wire. Put the filtered liquor quickly in an evaporating basin, along with twelve times its weight of quicklime around the basin, in some convenient apparatus in which it may be shut accurately in a small space not communicating with the general atmosphere. Heat the whole apparatus in a hot air-press, or otherwise, until the water be entirely evaporated; and preserve the dry iodide in small well-closed bottles.

The process adopted by the Edinburgh College is that suggested by Messrs. T. and H. Smith,[2] of Edinburgh. More recently[3] they have adopted another and an improved plan, in order more effectually to exclude atmospheric air. "According to our new plan, we make a solution of iodide of iron in a Florence flask, with six drachms of pure iron filings, two ounces and a quarter of iodine, and four and a half ounces of cold distilled water. After boiling till the liquid loses its dark colour, we filter rapidly into another clean flask, and, without delay, place the flask over the flame of a spirit lamp or gas-burner, and evaporate the liquid at a boiling heat. The ebullition may be allowed to proceed with very little attention for a considerable period, but when the liquid passes from a green shade into black, close attention becomes then necessary, as the process now approaches very near to its close. We can obtain the compound in two states,—either as a crystallised hydrate, or in an amorphous anhydrous form. To obtain it in the first form, an iron wire or a glass rod must be dipped into the liquid in the flask at short intervals, till, on removal and cooling, the iodide forms a dry and hard crust. When the evaporation has reached this point, on removal from the heat the fused iodide crystallises on cooling. To get the iodide in the anhydrous state, the evaporation must be carried still further. The period for bringing the application of heat to a close can very readily be judged of by occasionally placing a piece of cold glass over the mouth of the flask, and removing the heat when moisture ceases to be condensed on the glass. A pure, anhydrous, spongy protiodide will then be found in the flask, as during the whole operation the flask is filled with a body of steam continually given off by the liquid: the atmospheric air is completely excluded to the very last. We have also proved by the test of starch-paper that no free iodine is given off from the beginning to the end of the process.

---

[1] *Observations on the Preparation and Medicinal Employment of the Ioduret and Hydriodate of Iron*, 1834.

[2] *Edinb. and Lond. Journal of Med. and Surg. Science*, vol. i.

[3] *Pharmaceutical Journal*, vol. iii. p. 478, 1844.

"We now remove the iodide by breaking the flask and bruising pound coarsely in a warm, dry mortar, and enclosing it, without delay, in small well-corked bottles. If the process has been correctly the iodide will dissolve in distilled water, giving nearly a colourless or at least one having merely a slightly greenish and not a red tin not quite correct to term it completely soluble, as there is a minut insoluble matter left, being no doubt produced by a slight decompo the iodide occurring during filtration, but this will be in proportion l same extent as the care has been greater."

The *Dublin College* orders of Pure Iodine, ℥j.; Filings or Thin Turnings o Iron separated from impurities by a magnet, ℥ss.; Distilled Water, ℥v.: int iodine, iron, and four ounces of the water, into a Florence flask, and, having mixture gently for ten minutes, boil until the solution loses its red colour. Pas now through paper into a second flask, washing the filter with the remaining water, and, by means of a regulated heat, boil down the liquor until a drop of i on the end of an iron wire, solidifies on cooling. When the flask has assume perature of the air, let the iodide of iron be extracted from it (by breaking necessary), and, after it has been submitted to powerful pressure, enveloped i paper, let it be enclosed in a well-stopped bottle.

Fine soft iron wire, employed by the Edinburgh College, is to be to the iron filings used by the Dublin College. It should be recentl to free it from all rust. In this process one equivalent of iodine with one equivalent of iron, and forms one equivalent of protiodide o

The exclusion of the air is practised as much as possible during t tion to prevent the formation of sesquioxide of iron and the sep iodine. $2FeI+3O=Fe^2O^3+2I$. An excess of iron is used Edinburgh College to take up any iodine which may be set free by t of atmospheric oxygen.

Properties—By evaporation with as little contact of air as solution of iodide of iron yields green tabular crystals.[1] If the sol evaporated to dryness, and the residue be moderately heated, this salt and on cooling becomes an opaque, iron-grey, crystalline mass, with a lustre.

Iodide of iron has a styptic taste. It is fusible, volatile, very deliq and very soluble in both water and alcohol. By exposure to the undergoes decomposition, and deposits sesquioxide: its solution also un a similar change. The iron of the protiodide, which thus becomes o parts with its iodine. According to some persons, sesquiodide of formed. $6FeI+3O=Fe^2O^3+2(Fe^2I^3)$. But as the decomposed has the odour and flavour of iodine, and yields, on the addition of sta blue iodide of starch, it is more probable that it contains free iodine Phillips, Jun.[2] has suggested that, by the mutual action of iodide of ir water, hydriodic acid and protoxide of iron are formed. $FeI+HO=Fe$(The latter absorbs oxygen from the air, and becomes sesquioxide, $2FeO$ Fe^2O^3; while the hydriodic acid becoming oxidized under the joint in of air and light, yields water and free iodine. $HI+O=HO=I$. explanation is supported by the fact that the hydrated iodide of iron b more acid by exposure to the air, and that the addition of iodic acid alon the starch augments the amount of iodide of starch formed, because the iodic decomposes the hydriodic acid. $5HI + IO^5 = 5HO = 5I$.

---

[1] Mr. R. Phillips, *Translation of the Pharmacopœia*.

[2] *Pharmaceutical Journal*, vol. iv. p. 19, 1844.

Whatever be the change, it is important to know that by keeping a coil of iron wire in the solution of protiodide, as suggested by Mr. Squire,[1] no free iodine or sesquiodide of iron is produced, although the liquid may be fully exposed to air and light: sesquioxide of iron is formed, but if the solution be filtered, it is found to contain protiodide only. "A solution of protiodide of iron dissolves iodine abundantly, becoming brown, and possibly containing the sesquioxide, Fe^2I^3, but it is more likely that the iodine is not combined, as it is sensible to the test of starch."[2]

Characteristics.—When heated in the air, it evolves violet vapours of iodine, while the iron attracts oxygen from the air, and is converted into sesquiodide. A solution of protiodide of iron yields with a solution of corrosive sublimate a red precipitate,—$FeI + HgCl = HgI + FeCl$; and with ferrocyanide of potassium a bluish-white precipitate.

COMPOSITION.—The composition of iodide of iron is as follows:—

	At.	*Eq. Wt.*	*Per Cent.*
Iron	1	28	18·2
Iodine	1	126	81·8
Iodide of Iron	1	154	100·0

	At.	*Eq. Wt.*	*Per Ct.*	*J.D.Smith.*
Iron	1	28	14·	14·14
Iodine	1	126	63·3	43·64
Water	5	44	22·7	22·22
Hydrated Iodide of Iron	1	199	100·0	100·00

The iodide of iron of the Pharmacopœia contains, according to Mr. Phillips, five equivalents of water, $FeI,5HO$. Wittstein states that the hydrated iodide contains four equivalents only of water, $FeI,4HO$.

It appears from Mr. Scholefield's statement,[3] that iodide of iron, as prepared by the manufacturing chemist, usually contains only from 10 to 15 per cent. of water; for "if the process of evaporation be discontinued whilst the salt contains 22½ per cent. of water, it will be in so deliquescent a state as to be unavailable, unless for immediate use; whilst, on the other hand, if it be proceeded with until it attain the anhydrous state, the heat employed will occasion decomposition by a liberation of iodine and formation of sesquioxide of iron, in consequence of the slight affinity these bodies possess for each other. The medium course is generally pursued, the manufacturing chemist allowing the salt to retain from 10 to 15 per cent., which is soon increased by exposure to the air, together with a partial decomposition."

PURITY.—It should be perfectly soluble in water. By exposure to the air, it absorbs oxygen and forms sesquioxide.

Entirely soluble in water, or nearly so; forming a greenish solution.—*Ph. Ed.*

PHYSIOLOGICAL EFFECTS. α. *On Animals.*—Three drachms of iodide of iron were administered to a dog: vomiting and purging were produced, but in three days the animal was well. One drachm dissolved in a drachm of water killed a rabbit in three hours and a half, with the appearance of gradually-increased debility: the stomach was found congested, and its lining membrane decomposed. Forty grains injected into the jugular vein of a dog

---

[1] *Annals of Philosophy*, May 1836, p. 79; also, *Pharm. Journ.*, vol. i. p. 45, 1843.

[2] Kane, *Elements of Chemistry*, p. 732.

[3] *Pharmaceutical Journal*, vol. i. p. 521, 1842.

killed the animal within twelve hours: the symptoms were dilatat
pupils, staggering, vomiting, and bloody stools.

β. *On Man.*—In *small and repeated doses* its effects are not ve
save that of blackening the stools. It sometimes sharpens the ap
promotes digestion. It passes out of the system in the urine, and
constituents may be detected in this fluid. When it does not pu
quently acts as a diuretic. In *full doses*, as ten grains, it on or
caused uneasy sensation at the epigastrium, nausea, slight headach
black stool, and, in two hours, a larger quantity of urine, contai
iron and iodine.[1] Its medicinal influence on the body seems to be
hæmatinic, tonic, and alterative or deobstruent. It possesses the
properties of iron and iodine.

Sesqui-iodide of iron is said to produce the same effects, but to be more
iodide.[2]

Uses.—Iodide of iron is indicated as a tonic, hæmatinic, and re
cases of debility accompanied with a soft and relaxed condition of t
and paleness of the skin. It is especially applicable in scrofulous
mous affections of the glandular system, in which the use both of i
iron is indicated. In tabes mesenterica, and in swellings of the cer
phatic glands, it often proves highly advantageous. In chlorosis, an
amenorrhœa, Dr. Thomson found it serviceable; and his testimony o
effects has been supported by that of others. Its operation must be
by exercise, and an invigorating diet. In secondary syphilis, occ
debilitated and scrofulous subjects, it is in some cases, according t
timony of both Drs. Thomson and Ricord,[3] a valuable remedy.
mentioned writer employed it in the form of injection (composed of
a drachm to a drachm of iodide dissolved in eight ounces of
blenorrhœas, and in that of lotion in venereal and carious ulcers.
quin[4] employed it internally and externally in leucorrhœa and am
It has also been used in incipient cancer and in atonic dyspepsia (
Thomson).

Administration.—The dose of it is three grains gradually inc
eight, ten, or more. Ricord has given forty grains per day. It m
hibited in the form of tincture or of aqueous solution, flavoured wi
tincture of orange-peel It must be remembered that acids, alkalies,
carbonates, most metallic salts, all vegetable astringents, and man
solutions, decompose it. Pierquin gave it in chocolate, Bourdeaux
tilled water, diluted spirit, or made into lozenges with saffron and su
leucorrhœa and amenorrhœa, he employed an ointment (composed of
of iodine to an ounce of lard), by way of friction to the upper part of t

1. SYRUPUS FERRI IODIDI, L. E. D.; *Syrup of Iodide of Iron*
of Iodine, ℥j.; Iron, drawn into wire, ʒiij.; Distilled Water, f℥x
much as may be sufficient; Sugar, ℥x. Mix the iodine and iron w
fluidounces of the water, and heat until the solution acquires a

---

[1] Dr. A. T. Thomson, *op. cit.*

[2] *Lond. Med. Gaz.* June 18, 1841.

[3] *Journ. de Pharm.* xxiii. 303.

[4] Quoted by Dierbach, *Die neuesten Entd. in d. Mat. Med.* 2te Ausg.

colour; then strain. Evaporate the solution to about four fluidounces, and add the sugar. Lastly, when the syrup has cooled, add as much sugar as may be required to fill a measure of fifteen ounces; and keep it in a well-stoppered black glass vessel, *L.*—Iodine, dry, 200 grs.; Fine Iron-wire, recently cleaned, 100 grs.; White Sugar, in powder, ℥ivss.; Distilled Water, f℥vj. Boil the iodine, iron, and water together in a glass matrass, at first gently, to avoid the expulsion of iodine vapour, afterwards briskly, until about two fluidounces of liquid remain. Filter this quickly, while hot, into a matrass containing the sugar. Dissolve the sugar with a gentle heat, and add distilled water, if necessary, to make up six fluidounces. Twelve minims contain one grain of iodide of iron, *E.*—Take of Pure Iodine, ʒv.; Iron Turnings, separated by a magnet, ʒiij.; Distilled Water, ℥ij.; Simple Syrup, f℥vj. Introduce the iodine, iron, and water, into a glass flask, and apply a moderate heat until the solution loses its red colour. Filter the solution while hot into a bottle containing the syrup, mix with agitation, and add distilled water to make up eight fluidounces. One fluidrachm contains about five grains of iodide of iron, *D.*)—Mr. Redwood[1] states that when cane sugar is heated in contact with iodide of iron, it becomes very readily changed into grape sugar; and syrup of iodide of iron, as usually prepared, is very liable to become perfectly solid, in consequence of the crystallisation of the grape sugar. To obviate this and other changes which occur in this syrup when heat is used in its preparation, Mr. Hemingway[2] has proposed the following modification of the process :—

Take of iodine, pure and dry, ℥iij., ʒvij., ℈ij.; Iron filings, clean, ℥ij.; Distilled Water q. s. to make f℥xiiss. of the solution. Put the iron filings and half the water into a Wedgwood mortar or a flask, and add the iodine in small quantities at a time, agitating the mixture until it has become colourless; then filter the solution, and wash the iron with the remainder of the water. Keep it in a stoppered bottle, with a coil of iron wire. The liquid is called "*the solution.*" Each fluidrachm contains thirty grains of crystallized iodide of iron. When wanted for use pour it off without disturbing the sediment, and pass through a coarse filter. Take of simple syrup, f℥xv.; the solution of iodide of iron, as above, f℥ij. Gently evaporate the syrup over the fire until it has decreased in weight two ounces *avoirdupois*, then introduce it into a bottle, add the solution of iodide of iron, and shake them together. Repeat the agitation after the syrup has cooled, and keep it in small stoppered bottles. Each fʒj. of the syrup contains rather more than gr. iij. of the dry iodide; or four grains of the crystallized (hydrated) iodide. The syrup is faintly green.

[Mr. W. Tizier,[3] of Dublin, has offered the following practical suggestions respecting the preparation of this compound :—The new *Dublin Pharmacopœia* directs "to introduce the iodine, iron, and water into a glass flask, and apply a *moderate heat* until the solution loses its red colour." Now, as the great success of the first part of the process depends on the rapidity with which it is conducted, without any unnecessary exposure to air (but what cannot be avoided) until a neutral solution be effected, there is evidently considerable time lost, and danger of decomposition incurred, by pursuing these directions. This circumstance appears more remarkable, when we are aware that all extraneous application of heat is superfluous. Iodine and iron exert so powerful an affinity for each other in the presence of water, as to combine with the greatest facility, generating a large amount of sensible heat; at the same time it is only necessary then to bring the particles constantly in immediate contact with each other to fulfil this end to our entire satisfaction; and for this purpose two practical points must be attended to: first, to rotate the flask containing the mixed substances briskly and diligently for some moments in the hand, until the deep red colour of the solution disappears, and is succeeded by its olive green, pellucid, and

---

[1] *Pharmaceutical Journal*, vol. vi. p. 317, 1847.

[2] *Ibid.* p. 315.

[3] *Ibid.* 1850-51, p. 245.

normal one, which, wh
secondly, to break dow
adhering oxide, by whic
and thus ensure rapidit
rently insignificant poi
its practical difficulty,
will be entirely obviate
into the saccharine mas
the possibility of chang
Mr. Davenport,[1] of
ratum, this compound i
neous decomposition.—

Syrup of iodide of
the iodide, since it is
salt.[2] In the Edinb
or pale green; trans
Twelve minims o
grain of iodide (Chri
This preparation, the
The officinal syrup
day in doses varying
apt to occasion sick
decomposed by conta
air, when it is dilute
but the dilution shou
better to let the patie

2. PILULÆ FERRI
of Iodine, ℥ss. of co
strong stoppered oun
upon two drachms of
gradually half an oun
gum, and a drachm o
contains about a qu
Christison).

152. FERRI F
FERROCYA

Formula

History.—This co
of the last century
Berlin blue (*cærule*
ferroprussiate of ir
Preparation.—It
sulphate or perchlori

---

[1] *Lancet*, 1850, vol. i. p
[2] For some observations
in the *Pharmaceutisches C*
Ferri Saccharatum, by Ke

In commerce it is procured by adding a mixture of two parts of alum and one of sulphate of iron to an impure solution of ferrocyanide of potassium (called blood-lye or *lixivium sanguinis*). A dingy-green precipitate falls, which, by repeated washing with very dilute hydrochloric acid and exposure to the air, becomes gradually of a deep blue. It is then collected and drained on a cloth, and afterwards dried.

By the reaction of ferrocyanide of potassium on sulphate of the protoxide of iron, sulphate of potash is formed in solution, and a white precipitate subsides, which, by exposure to the air, becomes blue. Ferrocyanide of potassium, with sulphate of the sesquioxide of iron, forms sulphate of potash and ferrosesquicyanide of iron. Commercial Prussian blue contains alumina (derived from the alum), and usually some sesquioxide of iron.

[Pure Prussian blue is obtained by adding a solution of ferrocyanide of potassium to a solution of persulphate of iron. The precipitate thus obtained should be thoroughly washed with water slightly acidulated with sulphuric acid, and subsequently with pure water. It should then be dried in a warm place.

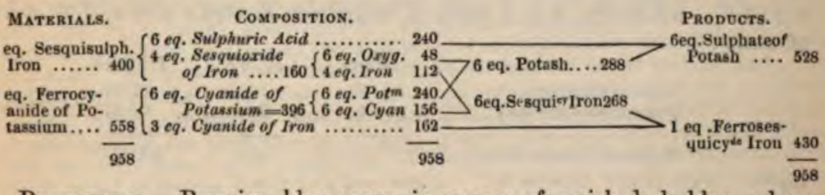
In this reaction three equivalents of ferrocyanide of potassium $3(K^2FeCy^3)$ decompose two equivalents of persulphate of iron $2(Fe^2O^3,3SO^3)$, and the equation may be thus represented—

$$\underbrace{3K^2,FeCy^3} + \underbrace{2Fe^2O^3,3SO^3} = 6KO,SO^3 + \underbrace{3Cy^3 + 2Fe^2}_{\text{Prussian blue.}} = \underbrace{7Fe,9Cy}_{\text{Prussian blue.}}$$

If the sesquichloride of iron be employed for the production of the precipitate, then the reaction will be as follows:—

$$\underbrace{3K^2,FeCy^3} + \underbrace{2Fe^2Cl^3} = 6KCl + \underbrace{3Cy^3 2Fe^2}_{\text{Prussian blue.}} = \underbrace{7Fe,9Cy}_{\text{Prussian blue.—ED.]}}$$

The following diagram illustrates the reaction of ferrocyanide of potassium on sulphate of the sesquioxide of iron:—


MATERIALS.
COMPOSITION.
PRODUCTS.
4 eq. Sesquisulph. Iron 400
6 eq. Sulphuric Acid 240
4 eq. Sesquioxide of Iron 160
6 eq. Oxyg. 48
4 eq. Iron 112
3 eq. Ferrocyanide of Potassium.... 558
6 eq. Cyanide of Potassium=396
6 eq. Potm 240
6 eq. Cyan 156
3 eq. Cyanide of Iron 162
958
958
6 eq. Potash....288
6eq.Sesquicy Iron268
6eq.Sulphateof Potash 528
1 eq .Ferrosesquicyde Iron 430
958

PROPERTIES.—Prussian blue occurs in masses of a rich dark blue colour. It is tasteless and inodorous. When broken or rubbed, it has a copper or bronze tint, somewhat like that of indigo, but which is distinguished from that of the latter by its being removed by rubbing with the nail. It is insoluble in water, alcohol, and the diluted mineral acids. Strong sulphuric acid forms with it a white pasty mass, from which water again separates Prussian blue. Both nitric acid and chlorine decompose it. Hydrochloric acid abstracts part of its iron.

Characteristics.—Its colour and copper tint above described form part of its characteristics. Boiled with water and binoxide of mercury it yields bicyanide of mercury. Boiled with solution of potash it forms ferrocyanide of potassium. Heated in a retort it yields water, hydrocyanate of ammonia,

then carbonate of an
mass.

The blue precipitate
iron, is called Turnbu
protocyanide of iron an
(6Cy+5Fe or 3Fe+(C
that, when boiled in a
potash, which is dissol
cyanide of potassium.

Basic Prussian Bl
prussian blue and 2 eq
exposing *ferrocyanide*
yellow prussiate of pot
and two products are o
2 eq. of ferrocyanide o
1 eq. yellow prussiate
sesquioxide of iron (Fe

Composition.—T
Prussian blue :—

Iron ....
Cyanogen ....

Ferrosesquicyanide of

[Or thus—

Iron ....
Ferrocyano

Prussian bl

Prussian blue con
prived without an alt
that it is rather a hy
as it is commonly
$2(Fe^2O^3)+3(CfyH^2)$
of water :—

Sesquioxide
Hydroferro

Hydrated P

Or—

Anhydrous
Water.......

Hydrated P

According to Bran
that in the ferridcyan

6Cfy
8Cfy

Purity.—Prussian
oxide of iron. Thes
with diluted hydrochl

ammonia added to the filtered solution throws down the impurities; excess of the alkali will redissolve the alumina.

PHYSIOLOGICAL EFFECTS. α. *On Animals.*—Coullon gave it to dogs and sparrows without killing them; and Schubarth states that the only effect produced on a dog by two drachms was dejection.[1]

β. *On Man.*—Its effects on man are not very obvious. It is reputed alterative, tonic, and febrifuge. Sachs[2] calls it a resolvent tonic.

USES.—It has been recommended by Dr. Zollickoffer[3] as a more certain, prompt, and efficacious remedy for intermitting and remitting fevers than cinchona; and particularly adapted for children, on account of its insipidity and smallness of dose. It may be administered during the paroxysm as well as in the intermission, and does not disagree with the most irritable stomach. Hosack,[4] Eberle,[5] and others, have borne testimony to its good effects. Subsequently, Zollickoffer found it useful in dysentery. Kirkhoff[6] used it for many years in epilepsy, with the best results, having cured some cases of several years' standing. It has also been employed by Dr. Bridges, of Philadelphia,[7] in a case of severe and protracted facial neuralgia, with very considerable relief. Lastly, it has been used in the form of ointment, as an application to foul ulcers.

In pharmacy it is employed in the manufacture of bicyanide of mercury.

ADMINISTRATION.—The dose of commercial Prussian blue is from four to six or more grains every four hours. The *ointment* above referred to may be prepared with a drachm of Prussian blue and an ounce of lard.

153. Ferri Pernitras.—Pernitrate of Iron.

Formula $Fe^2O^3,3NO^5$. *Equivalent Weight* 242.

Persesquinitrate of Iron; Ferrum nitricum oxydatum.—Obtained by dissolving iron, sesquioxide of iron, or the hydrated sesquioxide of iron, in nitric acid.

Mr. Kerr,[8] who introduced the use of this compound into medicine, gives the following directions for its preparation:—Take of small chips or pieces of iron-wire, ℥iss.; nitric acid, ℥iij. by measure; water, ℥xxvij.; hydrochloric acid, ʒj. Put the iron into an earthenware vessel, and pour on the nitric acid, previously diluted with fifteen ounces of the water. Set the vessel aside till the whole of the acid has united with the iron; then decant the liquid from the portion of iron which remains undissolved, strain, and filter. Add the hydrochloric acid with the remainder of the water, or with as much of that liquid as shall increase the whole solution to thirty ounces. The process usually requires from nine to twelve hours for its completion. Without the use of the hydrochloric acid the liquid is apt to become turbid in a few weeks. The solution when rightly made is of a beautiful dark red colour when viewed with transmitted light. Its taste is very astringent.

Its topical effects are those of a very powerful astringent and mild caustic. Mr. Kerr thinks that in addition to an astringent quality it possesses the property of diminishing the irritability and tenderness of the mucous membranes with which it comes in contact. Its

---

[1] Wibmer, *Wirk. d. Arzneim.* ii. 356.

[2] *Handwört. d. prakt. Arzneim.* ii. 557.

[3] *Treatise on the Use of Prussian Blue in Intermitting and Remitting Fevers*, Maryland, 1822.

[4] *New York Medical and Physiological Journal*, 1823, quoted by Richter, *Ausf. Arzneim.*

[5] *Mat. Med.* i. 233.

[6] Froriep's *Notizen*, Bd. xvii. 340.

[7] *United States Dispensatory.*

[8] *Edinb. Med. and Surg. Journ.* vol. xxxvii. p. 99, 1832.

and alvine hemorrhage
It seems well adapt
hemorrhage, in pale, fe
serve the double purpo
been used as a substitu
used of late, like the p
which it was used for r
state it has a powerful

The *dose* of it is from
spoonful three or four t
an ounce was swallowe
It may be given in plain
prove less effective as a
children it may be giv
employed from nine to
children. Diluted with
uterine hemorrhage.

Ferri Pernitratis Liqu
free from rust, ℥j.; Pur
the acid, first diluted wi
them in contact until ga
much water as will make
tion is 1107.

154. F

Formu

Ferrum oxydulatum ar
adding the arseniate of
iron. The white precip
soluble in water, and its s
effects are similar to thos
employed both internally
cancer. He applied from
ulceration. In about ha
hours, and is followed by
few days a slough is forme

---

[1] *System of Clinical Medi*

[2] *Denkwürdigkeiten der är*

tions, requires caution, as the arsenic becomes absorbed. It has been used by Biett[1] in lupus, elephantiasis, psoriasis, chronic eczema, and lichen. The dose of it is from $\frac{1}{16}$th to $\frac{1}{12}$th of a grain in the form of pill. It may be applied externally in the form of ointment composed of from ℈j to ʒss. of the arseniate to ℥j. of fat.

[The therapeutical properties of the arseniate of iron in the treatment of herpetic and squamous diseases of the skin has been lately minutely investigated by M. Duchesne Dupare;[2] and, in a memoir read before the French Academy, he advances the following propositions as the result of his researches:—

1. Arseniate of iron possesses, in common with all other arsenical preparations, unquestionable remedial properties, applicable to the treatment and cure of herpetic and squamous affections of the skin.

2. The great advantage of this substance is, that it may be administered in sufficient doses without giving rise to any of the consequences with which various other arsenical preparations have been justly reproached.

3. The arseniate of iron, whether given singly or in combination with other substances, ought always to be administered in graduated doses, commencing from one-twentieth, one-tenth, or even one-fifth of a grain, according to the age, the constitution, and above all, the state of the digestive organs of the patient.

4. Numerous facts, accurately observed, authorise M. Dupare in concluding, that a daily dose of one-fifth of a grain of arseniate of iron, uninterruptedly repeated during the necessary time, is competent in the adult to effect the cure of an herpetic or squamous affection, however extensive or long-established.

5. No absolute rule can be laid down with respect to the duration of the anti-herpetic treatment by arseniate of iron, for this must vary in accordance with the differences of age and constitution, the extent and severity of the disease, and, more than all, perhaps, in proportion to the degree of toleration which the digestive organs manifest for the remedy.

6. An anti-herpetic treatment by arseniate of iron in no degree excludes the employment of topical remedies of acknowledged utility, and it is materially assisted by the internal or external use of certain non-sulphuretted mineral waters. MM. Serres, Andral, and Rayer, have been commissioned to inquire into the merits of this new remedy.—ED.]

155. FERRI ACETAS.—ACETATE OF IRON.

Formula $Fe^2O^3,3\bar{A}$. *Equivalent Weight* 233.

HISTORY.—A solution of the sesquioxide of iron in acetic acid has long been known and used in the arts. It constitutes the *iron liquor* of the dyer and calico-printer. No formula for its preparation is given in the pharmacopœias of any of the British Colleges.

PROPERTIES.—[It may be made by saturating acetic acid with hydrated sesquioxide of iron.] It is a deep red liquid, having an acid, chalybeate taste. It reddens litmus.

Characteristics.—When heated, it yields acetic acid. Ferrocyanide of potassium strikes a blue colour with it, infusion of galls a purplish-black.

COMPOSITION.—This liquid is essentially a solution of the *acetate of the sesquioxide of iron*, $Fe^2O^3,3\bar{A}$. But when made from the carbonate of the shops, it may also contain *acetate of the protoxide of iron*, $FeO,\bar{A}$. The relative proportion of the two acetates depends necessarily on the proportion of the two oxides contained in the carbonate employed. The preparation may be considered as essentially a solution of the acetate of the sesquioxide of iron.

---

[1] Quoted by Aschenbrenner, *Die neuern Arzneimittel*. 1848.

[2] *Gazette des Hôpitaux*; and *Medical Times and Gazette*, Sept. 2, 1854, p. 246.

Ellermann's disinfecting fluid[1] contains the acetate of the sesq iron.

The PHYSIOLOGICAL EFFECTS and USES are the same as other f compounds.—The dose is from ten to twenty-five drops in water.

1. FERRI ACETATIS TINCTURA, D.; *Tincture of Acetate o* Sulphate of Iron, ℥viij.; Distilled Water, Oss.; Pure Sulphuric A Pure Nitric Acid, f℥ss.; Acetate of Potash, ℥viij.; Rectified Spir To nine ounces of the water add the sulphuric acid, and in the mix the aid of heat, dissolve the sulphate of iron. Add next the nitric diluted with the remaining ounce of water, and evaporate the resultin to the consistence of a thick syrup. Dissolve this in one quart, acetate of potash in the remainder of the spirit, and having mixed th and shaken the mixture repeatedly in a large bottle, let the whole b upon a calico filter. When any further liquid ceases to trickle subject the filter with its contents to expression, and having cl turbid tincture thus procured by filtration through paper, let it be that already obtained. The specific gravity of this tincture is 891.

[Mr. Arnell[2] remarks in reference to this method of preparing the that it frequently undergoes spontaneous decomposition by keepi made according to the directions given in the Dublin Pharmacopœia, of the iron separating in the form of sesquioxide, leaving the tincture less decolorized. This decomposition appears to arise from the becoming sufficiently oxidized by mere drying, especially in operating quantities. He has adopted the following modifications to prevent convenience arising from this change. To six and a half drachms of of iron add a sufficient quantity of nitric acid and a little water, an heat until a perfectly clear and bright solution of persulphate and p is obtained; add, if necessary, liq. potass. carb. to neutralize any e acid, or until a *permanent* precipitate begins to fall, then dissolve drachms of acetate of potash in the liquid, and carefully evaporate to Rub the mass with two pints of rectified spirit of wine, and filter. Th is a fine dark-red permanent mixture. The nitrate of potass formed in any way alter the product, it being insoluble in the spirit.—ED.]

In this process the sulphate of iron is decomposed by the acetate of the products being acetates of iron and sulphate of potash. FeO $7HO+KO,\overline{A}=FeO,\overline{A}+KO,SO^3$. The acetate of iron and the ex acetate of potash dissolve in the spirit; but the sulphate of potash is in in it. The two acetates are probably in combination, as suggested Barker,[3] forming a *ferro-acetate of potash*; for the solution, thou taining protoxide of iron, is unchanged by atmospheric oxygen. It is a coloured, perfectly transparent tincture, having a strongly chalybeate Dr Aldridge[4] found that the tincture may be decolorized by adding a s of sulphate of potash to it: he ascribes this to the acetate of potash carried down by the precipitating sulphate of potash, leaving unco protoacetate of iron in solution. It possesses the usual medicinal prope a ferruginous compound. It is a very agreeable chalybeate, and was introduced into the Dublin Pharmacopœia by Dr. Perceval.—The dose is from half a fluidrachm to one fluidrachm.

---

[1] *Pharmaceutical Journal*, vol. vii. p. 280, 1847.

[2] *Ibid.* 1851–52, p. 330.

[3] *Observations on the Dublin Pharmacopœia*, 1830.

[4] *Dublin Journal of Medical Science*, vol. x. 1836.

156. Ferri Lactas.—Lactate of Iron.

Formula $FeO,\bar{L},3HO$. *Equivalent Weight* 144.

Ferrum lacticum; Lactate of the Protoxide of Iron.—Obtained by dissolving metallic iron in dilute lactic acid: the solution is to be evaporated so that it may crystallise. Wöhler's process, as given by Dr. Christison,[1] is as follows:—Sprinkle in two pounds of sour whey an ounce of sugar of milk, and the same quantity of pure iron filings. Digest at a temperature of 100° F. until the sugar be dissolved, and then add another portion of sugar of milk. As soon as a whitish crystalline powder begins to form, the solution is strongly enough charged with lactate of iron. Then boil and filter into a close vessel; and the salt is partly deposited on cooling in greenish-white prisms, and partly forms a crystalline crust. These crystals, when slightly washed with cold water and quickly dried with bibulous paper, are pure enough for medicinal purposes; and they may be obtained quite pure by a second crystallization." The iron dissolves in the free lactic acid with the evolution of hydrogen gas: fresh lactic acid is furnished by the action of caseine (which acts as a ferment) on the sugar of milk. Lactate of iron is a greenish-white salt, in small acicular or prismatic crystals, which have a sweetish chalybeate flavour. They are soluble in 48 parts of cold or 12 parts of boiling water; and they are nearly insoluble in alcohol.

This salt was introduced into the Materia Medica by Gélis and Conté, whose memoir, on this subject, has been favourably reported on to the Académie Royale de Médecine by MM. Bouillaud, Fouquier, and Bally.[2] It was asserted to be superior to every other preparation of iron on the ground that iron after its administration is converted into a lactate by the lactic acid of the gastric juice, and the universal distribution of lactic acid through the body appeared to lend support to these statements. Bouillaud and others have found it useful in anæmia, amenorrhœa, dysmenorrhœa, and other maladies in which the chalybeates are generally found beneficial. It is administered in doses of from two to five grains. It may be given to the extent of half a drachm daily. It has been employed in a great variety of forms,[3] such as pills, *tablettes*, *pastilles*, *dragées*, bread (*iron-bread!*), and chocolate!! I agree with Mialhe[4] in opinion that there is no evidence of its superiority over the citrate or tartrate of iron.

157. Ferri Tannas.—Tannate of Iron.

Formula $F^2O^3,3\overline{Tan}$. *Equivalent Weight* 716.

Ferrum Tannicum.—"To a boiling solution of 90 parts of pure tannic acid, add gradually 440 parts of subcarbonate (sesquioxide) of iron, which has been prepared from pure sulphate of iron and carbonate of soda, and dried at a moderate heat. Agitate the solution till the effervescence ceases. Evaporate the mixture at 176° F. in a porcelain vessel, until it becomes thick; then spread it on glass or porcelain to dry in a stove at 95° F."[5] A *tanno-gallate of iron* (ink) is obtained by adding decoction of nutgalls to a solution of a salt of a sesquioxide of iron (as the persulphate). Tannate of iron is blue. According to Wittstein,[6] its formula is $F^2O^3,4\overline{Tan}$. As contained in ink it is usually mixed with a little gallate. Its properties are astringent, hæmatinic, and tonic. Ink is a

---

[1] *Dispensatory*, 2d edit. p. 975, 1848.

[2] *Bulletin de l'Académie Royale de Médecine*, 1840; also Mérat, *Supplément au Dict. de Mat. Méd.* p. 294, 1846; and *Brit. and For. Med. Rev.* vol. x. p. 565, 1840.

[3] See the various formulæ for these preparations in Bouchardat's *Nouveau Formulaire magistral*, 3me édit. p. 277, 1845.

[4] *Traité de l'Art de Formuler*, p. 184, 1845.

[5] Benedetti, quoted by Beasley, *Pocket Formulary*.

[6] Buchner's *Repertorium*, Bd. xlv. S. 280, 1847.

the two solutions cold,
washed it with the rem
rolled up in bibulous
well-stopped bottle.—E

159.

Two citrates of iron h

1. Ferri Protocitras
$\overline{Ci}$; Eq. Wt. ·273. Thi
dissolved in distilled wat
Bourchardat says it is a
doses of from gr. ij. to g

2. Ferri Percitras;
$\overline{Ci}$,2HO=263? Obtain
to a boiling solution of ℥
oxide than the acid will
consistence, spread out
separates in scales.[2] M
sesquioxide. It is found
in cold water, but readily
of the other citrates. D
Aqua carbonica cum fe
of thirteen grains of citra
orange-peel. Its flavour
shortly after it has been
The *Citrate of the Mag*
with citric acid, is similar

160. AMMONIÆ

Formula

History.—In 1831
a citrate of the sesquio

by this process is acid, and sparingly soluble in water. According to Mr. Hemingway,[1] M. Beral prepared and sold under the name name of *citrate of iron*, a salt which was neutral and readily soluble in water, and the formula for the preparation of which was different from the one published.

About 1842, a salt purporting to be similar to M. Beral's preparation was introduced into use in England, under the name of *citrate of iron*. This salt I found to contain ammonia; and in the second edition of this work (published in 1842) I called it *ferro-citrate of ammonia*, and stated that its composition was similar to Aikin's ferro-tartrate of ammonia.[2]

This salt is now commonly known in the shops as *ammonio-citrate of iron* (*ferri ammonio citras*), or the *citrate of iron and ammonia* (*ferri et ammoniæ citras*); but as the iron appears to enter into the composition of the acid or the electro-negative ingredient of the salt, the term *ferro-citrate of ammonia*, originally used by me, appears to be more appropriate. But in order to distinguish the ferro-citrate containing the sesquioxide of iron from those ferro-citrates which contain either the deutoxide or protoxide of iron, I have adopted Mr. Hemingway's suggestion,[3] and denominated it the *ferric citrate of ammonia*.

PREPARATION.—Mr. Redwood[4] gives two processes for the preparation of this salt:—

Take of crystallised Citric Acid, ℥iv.; Distilled Water, ℥xvj.; Moist Hydrated Peroxide of Iron, about ℥viij.; Solution of Ammonia, q. s. Dissolve the acid in the water in a Wedgwood's dish, heat the solution to boiling, then add the oxide of iron, which should be in slight excess. Continue the heat of a water-bath until no more oxide of iron is dissolved, then allow the solution to cool; add a little distilled water, to facilitate filtration, and filter the solution; add solution of ammonia until it becomes neutral to test paper; evaporate it at the heat of a water-bath to a syrupy consistence; spread it out on earthenware dishes, and dry with a gentle heat. When dry, it will separate from the dishes in scales.

This is Beral's process for the preparation of the citrate of the sesquioxide of iron, but modified by the addition of solution of ammonia. The second formula for the preparation of this salt given by Mr. Redwood, and which he says is the best, is the following:—

Take of crystallised Citric Acid, ℥iv.; Clean Iron Filings, or small iron nails, ℥ij.; Distilled Water, q. s.; Solution of Ammonia, q. s. Dissolve the citric acid in twenty times its weight of water in a Wedgwood's dish, add the iron, and apply a gentle heat until effervescence ceases, and no more iron is dissolved, renewing the water from time to time as it evaporates; filter the solution, and add solution of ammonia until it is slightly in excess; evaporate by the heat of a water-bath until it acquires a syrupy consistence; then spread it out in thin layers on earthenware dishes, and dry it with a gentle heat. When dry it will separate from the dishes in scales.

This is a modification of Mr. Aikin's process for the preparation of the ferric citrate of ammonia.

The London and Dublin Pharmacopœias both contain formulæ for this preparation under the name of ***Ferri Ammonio Citras***, L. D. The *London College* orders,

Sulphate of Iron, ℥xij.; Carbonate of Soda, ℥xiiiss.; Citric Acid, ℥vj.; Solution of

---

[1] *Lond. Med. Gaz.* March 15, 1844, p. 838.

[2] *Elements of Materia Medica*, vol. i. p. 868, 2d edit. 1842.

[3] *Lond. Med. Gaz.* March 29, 1844, p. 863.

[4] Gray's *Supplement to the Pharmacopœias*, 2d edit. 1848.

Ammonia, f℥ix.; Boili
separately in six pints
tate may subside. T
frequently with water,
it has cooled, add the
with a gentle heat, spr
closed vessel.

The formula of th

Take of Citric Acid,
Ammonia, f℥iv., or as n
the aid of heat, and, ha
iron, as directed in th
into the capsule contai
the solution has cooled,
transferred the solution
steam or water bath.
and preserve it in well-

Properties.—Th
red colour when exa
astringent. It is n
nearly insoluble in a

Characteristics.—
produces any effect
of a dilute mineral
dark blue precipitate
ammonia be heated i
ammoniacal gas take

Soluble in water. T
is not coloured blue by
water be added, sesquio
grains dissolved in wate
Ph. Lond.

Composition.—A
pound of *ammonia,*
quantity of sesquioxi
Hemingway[1] obtained
pared by himself; bu
only 30 per cent. A
of the ferric citrate o
following per centage
34.3; No. 3, 34.8; N
samples; Nos. 4 and
Society. No. 1 was
good; Nos. 4 and 5
$2\bar{Ci}$, $5HO$, would con
salt in the anhydrous

---

[1] *Lond. Med. Gaz.* Marc
one equivalent of citrate of i
equivalent for citric acid.
in the present work, it wi

According to Wittstein,[1] the composition of the ferric citrate is $5(NH^4,O),4Fe^2O^3,6\bar{C}i,18HO$. But the salt which he obtained does not appear to have been identical with that of English commerce, for he says that it was greenish yellow, and by drying, lost ammonia and acquired acidity. Moreover, a salt thus constituted would contain barely 20 per cent. of sesquioxide. Haidlen[2] obtained only 10 per cent. of the sesquioxide in the ferric citrate.

PHYSIOLOGICAL EFFECTS.—The topical effects of this chalybeate are very slight. It has very little taste, and that by no means disagreeable; and it rarely disagrees with the stomach. Like the other ferruginous salt in which iron is a constituent of the acid part, this has very little astringency.

The general or constitutional effects resemble those caused by other ferruginous compounds. Compared with the sulphate and sesquichloride I think that, for the quantity of iron which it contains, it is inferior in activity to them.

USES.—The great advantages of this preparation, as a chalybeate, are, 1st, its being devoid of any disagreeable flavour, so that it is readily taken by children and delicate persons; 2dly, its being devoid of irritating properties, so that it is not apt to disturb the stomach; 3dly, its being readily soluble in water, and forming a very agreeable solution; 4thly, it may be given in conjunction with the alkaline carbonates, and many other salts often required when chalybeates are administered. On the other hand it has its disadvantages: 1st, being devoid of astringent properties it is unfitted for those cases in which the chalybeates are resorted to on account of their topical effects; 2dly, it appears to me to operate on the general system more slowly and less powerfully as an hæmatinic than the sesquichloride or sulphate. In extreme anæmia from violent hemorrhage, where an immediate and powerful hæmatinic is required, the ferric citrate of ammonia is inferior to the chalybeates just mentioned.

But in ordinary cases of debility requiring a ferruginous tonic, especially where the stomach is irritable, or where the alkaline carbonates are required to be conjoined, and also in the various strumous affections of children, the ferric citrate is a valuable and useful preparation.

ADMINISTRATION.—It may be given in doses of from gr. v. to gr. x. dissolved in water, flavoured with syrup of orange peel, or in some bitter infusion, as of gentian or calumba.

161. Ammoniæ Ferrico-Tartras.—Ferric Tartrate of Ammonia.

Formula $NH^3,Fe^2O^3,\bar{T}$? *Equivalent Weight* 229?

Ammoniæ Ferro-Tartras; Ferro-Tartrate of Ammonia; Tartrate of Iron and Ammonia; Aikin's Ammonio-Tartrate of Iron. This salt was first employed in medicine by Mr. C. Aikin.[3]

It may be prepared by adding caustic ammonia to a solution of tartrate of iron (prepared by digesting together, for two or three days, one part of tartaric acid, dissolved in hot water, with two or three parts of iron filings). The green solution thus obtained is to be evaporated to dryness by a gentle heat. Mr. Procter, of Philadelphia, prepares it by adding hydrated sesquioxide of iron to a solution of bitartrate of ammonia.

It is in the form of shining brittle fragments of a deep red colour, not very unlike pieces of deep-coloured shell-lac. It is very soluble in water. Its taste is strongly

---

[1] Buchner's *Repertorium*, 2ter Reihe, Bd. xlii. S. 299, 1846.

[2] *Ibid.* Bd. xxxiv. S. 397, 1844.

[3] *Lond. Med. Gaz.* vol. xiii. p. 438.

saccharine. According
iron.

Its general effects are
that it has very little if
ready solubility in water,
with various saline sub
oxide of iron than the
grains in powder, pill, or
by the taste. It may
decomposition.

162. POTAS

For

History.—This p
commencement of th
mode of preparation.
perties.[3]

This compound ha
(*tartarus chalybeat*
rum tartarizatum,
tartrate of iron (*fe*
(*potassæ ferro-tartr*
tartras).

Preparation.—So
Take of powdered
parts; Moist Hydrat
Digest them, at the
ceases to dissolve a
dryness by a gentle h

The process of the

Sulphate of Iron, ℥iv.;
f℥x.; Bitartrate of Pot
phate in a pint of water
the nitric acid. Boil the
the water; then add the
it aside for twenty-four h
distilled water, and to it
being poured off. Separa
dissolved, then evaporat
tartrate may be dried in t

In this case hydrate
phate by ammonia, an
nation takes place, an

The *Edinburgh College*
ʒj.; Carbonate of Ammon
the sulphate as directed

---

[1] *London Medical Gazette*
[2] *An Experimental Exami*
[3] *Lond. Med. Rev.* No. xi
[4] *Nouveau Traité de Phar*

four pints of water; add the Bitartrate; boil till the rust of iron is dissolved; let the solution cool; pour off the clear liquid, and add to this the carbonate of ammonia so long as it occasions effervescence. Concentrate the liquid over the vapour-bath to the consistence of a thick extract, or till the residuum becomes on cooling a firm solid; which must be preserved in well-closed vessels.

The explanation of the formation of hydrated sesquioxide of iron (here called *rust*) has been already explained. The theory of the other part of the process is the same as that of the process of the London Pharmacopœia.

Under the name of ***Ferrum Tartarizatum*** the ***Dublin College*** orders—

Sulphate of Iron, ℥viij.; White Bitartrate of Potash, ℥v.; Distilled Water, Oiss. From the sulphate of iron prepare the hydrated peroxide of iron, by the process for *Ferri Peroxydum Hydratum*, and, having immediately after it is washed, placed it with the bitartrate of potash and water in a porcelain capsule, apply heat to the mixture (taking care, however, that the temperature does not rise beyond 250°) and stir it occasionally for six hours. Let the solution, after it has cooled down to the temperature of the atmosphere, be decanted off any undissolved oxide of iron, and having transferred it in small quantities to delf dinner-plates, let it be evaporated to dryness at a heat not exceeding 150°. Lastly, chip off the film of dry salt which adheres to the plates, and preserve it in well-stopped bottles.

[Mr. W. Bastick,[1] in some remarks on ***potassio-tartrate of iron***, criticises the formulæ given for the preparation of this compound in the British pharmacopœias, and states that they all give uncertain results. His experiments, analytical and synthetical, lead him to coincide with Soubeiran and Capitaine, who give $\bar{T},KO,Fe^2,O^3$, as a correct representation of the constitution of potassio-tartrate of iron. Therefore, 189 parts of bitartrate of potash, and 80 parts of peroxide of iron, are the best proportions to form this salt. The method by which, in practice, these proportions may be correctly obtained is the following:—

Take 278 parts of protosulphate of iron and convert them into persalt by means of nitric acid. Precipitate the peroxide of iron from this solution by caustic potash; thoroughly wash on a filter the precipitate thus obtained. Introduce into a suitable vessel 189 parts of bitartrate of potash with six times its weight of water; to these add the filter and its contents. The whole is to be digested with a gentle heat, and frequently stirred, until a perfect solution is formed; the filter is then to be removed, and the liquid to be evaporated until it has the consistence of treacle. It may now be spread on well-glazed earthenware, and evaporated to dryness; it may then be detached in thin laminæ.

The salt thus prepared is perfectly soluble,—certain in composition, and consequently more sure in its effects than those formed by other less accurate methods.

The bitartrate of potash employed by Mr. Bastick was formed by the direct combination of tartaric acid and bicarbonate of potash to avoid the contamination of lime usually found in the cream of tartar of commerce.—ED.]

PROPERTIES.—This compound is an olive-brown inodorous powder, with a styptic inky taste. It reacts on vegetable colours, mildly alkaline. It is slightly deliquescent, probably from the tartrate of potash which it contains. It dissolves in about four times its weight of water, and slightly in alcohol.

Characteristics.—If ferrocyanide of potassium be added to a solution of ferrum tartarizatum, no blue colour is produced; but if a few drops of an acid (as dilute sulphuric acid) be added, Prussian blue is immediately formed. Potash, soda, or their carbonates, do not decompose this solution at ordinary temperatures; nor does ammonia or its carbonates, even by the aid of heat.

---

[1] *Pharmaceutical Journal*, 1850-51, pp. 441-446.

Tincture of nutgalls caus
or hydrochloric acid, cause
acid; the solution has the
formation of crystals of tar
potash yields charcoal, car

COMPOSITION.—The fo
tartrate of potash, accordi

The salt obtained by Sc
tion :—

	At
Potash......................	
Sesquioxide of Iron......	
Tartaric Acid	
Tartarized Iron	

But the pharmacopœial
18 per cent. of sesquioxid
tion of this salt is as follo

	At.	Eq.Wt.	
Potash	2 ...	94	...
Sesquioxide of Iron	1 ...	80	...
Tartaric Acid	2 ...	264	...
Tartarized Iron ...	1 ...	438	...

As neither ferrocyanide
in a solution of this salt, t
stituent of the acid, or el
therefore, regarded as a do
oxide, as the acid or electr
basic or electro-positive in
tartrate of iron and ferrate

PURITY.—In commerce
compound, in which none
combination with bitartra
soluble in water, and the s
of potassium, and throws
potash. The following are

Soluble in water. The solut
not rendered blue by ferrocyan
of an alkali. If warmed with
sesquioxide of iron weighing ab
Entirely soluble in cold wat
aqua potassæ, and not precipita

PHYSIOLOGICAL EFFECTS
most part, with other ferrug
tively slight; its astringenc
and consequently its consti

---

[1] *Journal de*
[2] *Translatio*
[3] *Handb. d.*

lating influence over the vascular system is said to be somewhat milder. These peculiarities in its operation are supposed to depend on the tartaric acid and potash with which it is in combination.

USES.—It is not frequently employed, yet it is a very eligible preparation of iron, and may be used wherever the ferruginous tonics are indicated.

ADMINISTRATION.—The dose of it is from ten grains to half a drachm, in the form of solution or bolus, combined with some aromatic.

This salt was formerly employed in medicine, under the name of *globuli martiales* or *boules de Nancy*; they were wrapped in a piece of muslin and suspended in water to form a chalybeate solution.

VINUM FERRI; *Wine of Iron; Steel Wine.* In the London Pharmacopœia of 1851 this is ordered to be prepared as follows:—Take of Iron Wire, ℥j.; Wine [Sherry], Oij. Digest for thirty days and strain.

The iron suffers oxidation by the united influence of air and water, and the oxide of iron thus formed combines with the acids (malic, tartaric, and acetic?) contained in the wine.

Vinum ferri is a weak chalybeate; it is sometimes administered to scrofulous and anæmic children, and to other persons. The dose of it is fʒj. to fʒiv., or more.

ORDER XXVIII. COPPER AND ITS COMPOUNDS.

163. CUPRUM.—COPPER.

Symbol Cu. *Equivalent Weight* 32.

HISTORY.—*Cuprum*, or *copper*, received its name from Κύπρος, the island of Cyprus, where it was first discovered, or at least workedto any extent. It seems to have been known in the most remote ages of antiquity, for Moses[1] speaks of brass (an alloy of copper and zinc). The alchymists called it *Venus*, ♀

NATURAL HISTORY.—It is found in both kingdoms of nature.

a. IN THE INORGANISED KINGDOM—Copper is found in the metallic or reguline state (*native copper*); combined with oxygen, both as protoxide, Cu^2O (*red copper ore*), and oxide, CuO (*black copper*); combined with sulphur, as the protosulphuret Cu^2S (*glance copper*), and as sulphuret CuS (*blue* or *indigo copper*), and also forming double sulphurets (*variegated copper* $FeCuS$, *copper pyrites* $FeCuS^2$, &c.); combined with selenium; with chlorine (*atacamite* or *muriate of copper*); and with oxygen and an oxyacid (*carbonate, phosphate, sulphate, silicate, vanadiate*, and *arseniate*). It is also found in meteoric iron, in very small quantity, according to Berzelius, in Saidschütz water, and in some earths.

β. IN THE ORGANISED KINGDOM.—It has been discovered in the ashes of most plants, as of stavesacre, rhatany, flax, nux-vomica, and hemlock. Sarzeaux has detected it in the blood of animals.[2]

PREPARATION.—The copper of commerce is usually prepared from *copper pyrites* (the double sulphuret of copper and iron). The greater part of the ore raised in Cornwall is of this kind. It is roasted and then smelted, by

---

[1] *Job*, ch. xxviii.

[2] *Ann. d. Chim.* xliv. 334.

which *coarse metal* is
which we obtain *fine me*
and smelting, *coarse co*
smelting effect the expul
The copper thus produce
volatile matters, by whi
toughened by melting it

Properties.—It is a
hedra and cubes, havin
ductile: it has a nause
smell. It fuses at 1996
volatilized. It is combu
and fatty bodies, when p
with oxygen; and, by di
poisonous properties.

Characteristics.—Co
communicating a green
the solution possesses th
with potash or soda it yi
CuO,HO); a small quan
white precipitate, but a
($2NH^3$,CuO,NO^5); ferr
precipitate (*ferrocyani*
and the hydrosulphurets
CuS); and lastly, a polis
with metallic copper. C

Physiological Effec
to produce no pernicious
metallic state; as many c
swallowed, and retained f
and Drouard[2] gave as m
different ages and sizes,
therefrom.

Notwithstanding these
to it. Thus Cothenius[3]
and the late Professor Ba
who, having swallowed a
pints of saliva. Lastly,
incorporated with crumb
no doubt that the effec
metal by the acids of the

2. **Of the Cupreous Co**
Copper.

β. *On Animals.*—Th
In large doses they act as

---

[1] J. H. Vivian, *Ann.*
[2] *Exper. et Observ. su*
[3] Voigtel, *Arzneimitte*
[4] Chapman, *Elem. of*
[5] Orfila, *Toxicol. Géné*

In animals killed rapidly by these poisons no morbid appearances are found, in consequence of death being produced by their action on the nervous system; but when the death was slow, marks of gastro-intestinal inflammation, and occasionally indications of inflammation of the brain, have been observed.

γ. *On Man.*—The topical action of the cupreous salts is that of caustics, irritants, and astringents. On account of their action on sulphuretted hydrogen and the hydrosulphurets, they are applicable as disinfectants, but to a less extent than other metals.

They become absorbed. Drouard and others were of opinion that the preparations of copper did not become absorbed, but Lebkuchner (quoted by Christison) has detected copper in the blood of the carotid artery of a cat into whose bronchial tubes he had injected four grains of the ammoniacal sulphate, and Wibmer[1] has found it in the liver of animals to whom he had given the acetate for several weeks. Most, if not all, the preparations of copper are poisonous in large doses. The sulphuret and ferrocyanide are doubtful exceptions to this statement.

If the cupreous preparations be used in *very small* doses, they sometimes give relief in certain diseases principally of the nervous system, without obviously disordering the functions; in other words, in these instances the only apparent effect is the modification observed in the morbid condition. These are the cases in which these preparations have been termed *tonic*, *antispasmodic*, or *alterative*, according to the nature of the disease; thus, in ague they have been termed tonic, in epilepsy antispasmodic, in dropsy alterative. The beneficial operation is presumed to be owing to some influence exerted by the remedy over the nervous system.

The effects produced by the long-continued use of small doses of the preparations of copper have not been satisfactorily determined; they are said to be various affections of the nervous system (such as cramps or paralysis), alteration of the colour of the skin, chronic inflammation of the respiratory and digestive apparatus, slow fever, and wasting of the body. These symptoms constitute what has been termed *slow* or *chronic poisoning by copper*. The smelters or workers in copper do not suffer from the vapour or emanation of this metal, as the workmen employed in the preparation of mercury, of arsenic, or of lead, do, from the vapours of these metals: this, indeed, might be expected, when we consider how much more volatile the latter and their preparations are, than copper and its compounds. [Dr. Corrigan, of Dublin,[2] after detailing some cases of slow copper-poisoning, comes to the following conclusions:—"1st. That copper, or its carbonate, will act as a slow poison by absorption, undermining the constitution, producing emaciation, catarrh, and loss of strength, and leaving the system in a state little capable of resisting the ordinary exciting causes of many diseases. 2nd. The symptoms, although not acute, are well marked,—emaciation, a cachectic appearance, loss of muscular strength, colicky pains, cough without physical signs to account for it, and the peculiar characteristic sign of retraction of the gums, with a purple, not a blue edge. 3rd. In none of the cases, although there was muscular debility, was there either acute colic with constipation, or the local paralysis that so often results from the poison of lead, and the colour of the gums was quite distinct from that produced by lead. 4th. Copper, in slow poisoning, seems

---

[1] *Wirk. d. Arzn.* ii. 244.

[2] *Dublin Hospital Gazette.*

to exert its deleterious i
lation, including absorpt
nervous system of both
former by the obstinate
lead colic, and by the p
ledge that copper, or its
poison, will be useful, a
rently, at first sight, ano
nosis. The tint of colo
remains a very long time
rated, so long as they w
man, who has been very
duced by lead was very
Previously to his becomi

In *larger*, or full me
speedy vomiting, with le

In *still larger* quanti
intestinal inflammation,
(especially the cerebro-sp
The usual symptoms ar
purging, griping pains,
convulsions, and insensi
cases the cerebro-spinal
of the alimentary canal.
served that death was som
the symptoms being thos
system. By some toxic
the *irritant* poisons, al
them astringent.

Uses. α. *Of Metalli*
grains, were formerly use
effects of the bite of a m
the Appendix to the Lon
as well as the nature of
acid, and it enables the p
silver, and antimony. Fo
woven copper-gauze, may

β. *Of the Cupreous C*
external and as internal re
and caustics; internally,
Some of them have also b

Antidotes.—The chen
men; hence, the whites
wheaten flour, should b
Navier, by Payen and C
Edwards. The iron deco
in the metallic (and, ther
tassium is also said to t

---

[1] *Me*
[2] *Tox*

taken with safety, for it is not so poisonous as was at one time imagined. *Sugar* was proposed by Marcelin Duval as an antidote; its efficacy, though denied by Orfila and Vogel, has been lately reasserted by Postel. The alkaline sulphurets formerly used are worse than useless, since they are active poisons. The inflammatory symptoms are of course to be subdued by the usual means.[1]

164. CUPRI SULPHAS.—SULPHATE OF COPPER.

Formula CuO,SO^3. *Equivalent Weight* 80.

HISTORY.—This substance was probably employed by Hippocrates,[2] under the name of *κύανος*, to promote the healing of ulcers. Pliny[3] also was doubtless acquainted with it, though he seems to have confounded it with sulphate of iron. His *chalcanthum cyprium* was, perhaps, sulphate of copper. This salt has had various other names; such as *blue vitriol*, (*vitriolum cæruleum*), *Cyprus vitriol* (*vitriolum de Cypro*), *Roman vitriol*, *blue copperas*, *blue stone*, and *bisulphate of copper*.

NATURAL HISTORY.—It occurs in copper mines, as those of Cornwall, and is formed by the joint action of air and water on sulphuret of copper. The cupreous solutions of copper mines are termed *waters of cementation*.

PREPARATION.—It may be prepared by evaporating the water found in, or issuing from, copper mines. It is also produced by roasting copper pyrites, lixiviating the residuum to dissolve the sulphate, and evaporating so as to obtain crystals. In this process both the sulphur and the copper of the pyrites abstract oxygen from the air, and become, the one sulphuric acid, the other oxide of copper: these by their union constitute the sulphate of copper. The sulphate obtained by this process is impure, being contaminated with the sulphate of iron.

Sulphate of copper is "occasionally prepared by dissolving in sulphuric acid an oxichloride of copper, made for the purpose, by exposing sheet copper to the joint action of air and hydrochloric acid.[4] It is also obtained in large quantities in certain processes for refining gold and silver. For the following information respecting its production at the Mint I am indebted to the kindness of Mr. Brande:—

> "A large quantity of sulphate of copper is occasionally obtained here as follows:— When ingots of silver are found to contain a certain quantity of gold, they are melted, granulated, and boiled in sulphuric acid, by which sulphate of copper is formed, and the gold remains in a pulverulent form: the sulphate of silver is then decomposed by the immersion of copper plates; the silver is precipitated in a fine crystalline powder, washed, pressed into masses, and melted, and so affords pure silver, which is afterwards made standard by alloying it with copper, and used for the coinage: the resulting sulphate of copper is then crystallised and sold.
>
> "When gold ingots contain a certain quantity of silver, they undergo a similar process. Suppose a certain number of ingots of gold contain 2 or 3 per cent. of silver,—instead of leaving it, as formerly, to constitute a part of the standard alloy, it pays to extract it, and substitute copper in its place. To get the silver out of the said ingots they are

---

[1] For further details on this subject, consult the works of Drs. Christison and Taylor.

[2] *De Ulceribus*, p. 880, ed. Fæs.

[3] *Hist. Nat.* xxxiv. 32.

[4] Brande's *Manual of Chemistry*, 5th edit.

melted with about 3 par
sulphuric acid,—the gold
into sulphate, which is de
copper is obtained."

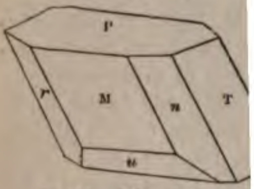
[For commercial purpos
action of sulphuric acid u
gone the process of anne
wooden troughs lined wit
leaden pipe dipping to the

This preparation, under
E. D., forms an article of
Edinburgh and Dublin Co
College has given the follo

Cupri Sulphas, L.—Tak
boiling, Oiv. Pour the w
it is dissolved. Strain the
form. Evaporate the sol
them all.—It is soluble in

PROPERTIES.—This

FIG. 143.



Doubly oblique Prism o
Sulphate of Copper.

Characteristics.—I
the sulphates; and as
sulphuretted hydrogen
potassium a red brown
dark purple blue-colour
which copper is precipi

COMPOSITION.—Its c

Oxide of Copper..........
Sulphuric Acid ....
Water......................

Crystallised Sulphat

IMPURITY.—The com
generally contains trace
of ammonia, which thro
copper.

It is soluble in water. W
of ammonia should dissolve.

PHYSIOLOGICAL EFFECTS. α. *On Vegetables.*—It is poisonous to plants:[1] hence its use in preventing dry rot (*Merulius lachrymans*), by soaking timber in it, according to Mr. Margary's patent; and in destroying or preventing the Smut (*Uredo segetum*), or Bunt (*U. caries*), in corn, by immersing the grain in a weak solution of it: the solution is not made sufficiently strong to injure the seed. [It has been also largely used for preventing the dry rot in timber, as a substitute for corrosive sublimate. It coagulates the albuminous liquids in the woody fibre, and forms an imputrescible compound. —ED.]

β. *On Animals.*—This salt operates as a poison to animals. Six grains killed a dog in half an hour, without producing any appearance of inflammation (Drouard). Applied to a wound it destroyed the animal in twenty-two hours, and the body was every where in a healthy state.[2] Orfila[3] also found that it proved fatal in a few hours when applied to wounds. The only symptoms mentioned are dulness, loss of appetite, and sometimes purging. Inflammation of the mucous membrane of the stomach and rectum was found after death.

γ. *On Man.*—In *very small doses* it has no sensible operation on the body, although it occasionally ameliorates certain diseases, such as epilepsy and ague: in these cases it has been denominated an antispasmodic and tonic. The local action on the alimentary tube is that of an astringent. Dr. Elliotson[4] has known a patient to take it for three years, for a particular kind of diarrhœa, without any constitutional effect. I have administered six grains thrice a day for several weeks, in an old dysentery, without any other obvious effect than slight nausea and amelioration of the disease for which it was given. In *larger doses* it is a safe and useful emetic, acting very speedily, and without exciting any great disorder of the general system. In *excessive doses* it becomes a poison, producing inflammation of the alimentary canal, and disordering the functions of the nervous system, as noticed when describing the action of cupreous preparations generally. In a case mentioned by Dr. Percival,[5] two drachms proved fatal; the patient was violently convulsed. In a more recent case[6] there were vomiting and insensibility, but no convulsions or purging: the child died in four hours.

Its topical action is stimulant, astringent, styptic, and caustic. Its causticity depends on its union, either as a neutral or basic salt, with one or more of the constituents of the tissues. Thus it combines with albumen to form a pale bluish green compound, which produces with caustic potash a violet-coloured solution[7]. According to Lassaigne,[8] the bluish white precipitate which sulphate of copper occasions in a solution of albumen is composed of *albumen* 90·1, and *sulphate of copper* 9·9. But Mulder regards it as an albuminate of the oxide of copper.

USES.—Where speedy vomiting without much nausea is required, as in

---

[1] De Candolle, *Phys. Vég.* 1335.
[2] Duncan, in Christison *On Poisons*, 432.
[3] *Toxicol. Gén.*
[4] *Lond. Med. Gaz.* xii. 557.
[5] *Transactions of the London College of Physicians*, iii. 88.
[6] *Lond. Med. Gaz.* xviii. 624 and 742.
[7] Dr. C. G. Mitscherlich, *Brit. Ann. of Med.* i. 751 and 817, and ii. 51.
[8] *Journ. de Chim. Méd.* t. vi. 2de sér.

cases of narcotic poiso
emetic. It has also
croup, and thereby to

As an *astringent* it
and dysentery.[2] It o
fail. It should be giv
twice or thrice a day,
most excellent effects i
The largest dose I hav
is also used as an astri
urino-genital mucous

As a *tonic* or *antis*
as the ague; and in so
rea). In epilepsy it
Hawkins.[4]

As a *topical* agent,
cation to ulcers, either
granulations, commonl
process of cicatrization
agents we can employ
membranes to diminis
chronic ophthalmia, a
discharges from thes
membranes (especially
of copper, in substance,

As a *styptic,* a soluti
hages from a number o
brandy impregnated wit
which occurred in a yo
hands of Dr. T. J. Tod

It may be used as a d
or hydrosulphuret of am
forming sulphuret of co

ADMINISTRATION.—T
grains to fifteen; as an
two, or more grains, giv
for external purposes
but usually from one or
of water, are employed.

ANTIDOTES.—See *ant*

CUPRUM ALUMINATU

Lapis Ophthalmicus.
Alum, of each ℥iij. Ha
earthen crucible until th

---

[1] *Brit. and For. Med. Rev*
[2] Elliotson, *Lond. Med. G*
[3] *Lond. Med. Journ.* i. an
[4] *Lond. Med. Gaz.* viii. 18
[5] *Cyclop. of Pract. Med.* i.

phor in powder, mix, and pour out on an oiled slab. When cold, break the mass into pieces, and preserve in a stoppered bottle). A solution of ʒj. of this substance in 32 fluidounces of water forms the *collyre dit pierre divine*, which is used as an eye-wash.

165. AMMONIÆ CUPRO-SULPHAS.—CUPRO-SULPHATE OF AMMONIA.

Formula $NH^3,CuO+NH^3,HO,SO^3$. *Equivalent Weight* 123.

HISTORY.—Boerhaave was acquainted with an ammoniacal solution of copper. In 1757, Weissman gave imperfect directions for its preparation. In 1799, Acoluth published a better process. Dr. Cullen introduced this substance into practice in this country. It is usually called *ammoniated* or *ammoniacal copper* (*cuprum ammoniatum*, vel *ammoniacum seu ammoniacale*) or *ammoniuret of copper* (*cupri ammoniuretum*). It is also termed the *ammonio-sulphate of copper* (*cupri ammonio sulphas*)

PREPARATION.—All the British Colleges give directions for the preparation of this compound, which is designated in all the Pharmacopœias as CUPRI AMMONIO SULPHAS.

The *London College* orders of Sulphate of Copper, ℥j.; Sesquicarbonate of Ammonia, ℥iss. Rub them together until Carbonic Acid ceases to escape; then wash the Ammonio-sulphate of Copper, wrapped in bibulous paper, in the air.

The directions of the *Edinburgh College* are essentially similar; with the addition that the product is to be preserved "in closely-stopped bottles."

The *Dublin College* employs of Sulphate of Copper, *two ounces*; Commercial Sesquicarbonate of Ammonia, *three ounces*.

The proportions of ingredients employed are about one equivalent of sulphate of copper, and one and a half equivalents of sesquicarbonate of ammonia. When rubbed together, these salts give out part of their water of crystallisation, by which the mixture becomes moist; and, at the same time, a portion of the carbonic acid of the sesquicarbonate escapes, producing the effervescence alluded to; and the compound acquires a deep azure-blue colour. This colour is probably owing to cuprate of ammonia; for oxide of copper with caustic ammonia forms a similarly-coloured liquid.

If this view be correct, the decomposition may be thus explained:—An equivalent of hydrated sesquicarbonate of ammonia reacts on one equivalent of crystallised sulphate of copper, and produces one equivalent of cuprate of ammonia, one equivalent of sulphate of ammonia, six equivalents of water, and three equivalents of carbonic acid. $CuO,SO^3,5HO+2NH^3,2HO,3CO^2 =NH^3,CuO+NH^3,HO,SO^3+6HO+3CO^2$. The combined cuprate and sulphate of ammonia represent the crystallised cuprosulphate of ammonia (*cuprum ammoniacale*). The pharmacopœial preparation contains an excess of the sesquicarbonate of ammonia.

PROPERTIES.—It has a deep azure-blue colour, a styptic metallic taste, and an ammoniacal odour. It reacts on vegetable colours as an alkali; thus it reddens turmeric, and restores the blue colour of litmus, which has been reddened by an acid. By exposure to the air ammonia is evolved, and a green powder is left, composed of sulphate of ammonia and carbonate of copper.

To prevent this, there
It is soluble in water
present, the solution,
Cuprosulphate of am
Dr. Kane[1] considers
Characteristics.—
acid, a green precipita
dissipated, save the o
sulphate of potash is
and ammonia is disen
by the barytic salts.

Pulverulent, of a blue
evolving at first sesquica
This solution changes the
renders it of a green colo

Composition.—Th
of ammonia. This, i

Ammonia ....
Oxide of Copper ....
Sulphuric Acid......... ...
Water ....

Crystallised Cupro-sulpha

It is probably a do
ammonia, $NH^3,CuO+$

Ammoniated Copper of
carbonate (bicarbonate ?)
copper.

Physiological Eff
phate of copper. Wi
grains dissolved in w
respiration and circul
and purging were pro
its action on the nervo
of sulphate of copper,
and vomiting. An ov
is probably somewhat
It is employed in medi
Uses.—*Internally,*
affections; such as epi
of the stomach. In
useful by Dr. Cullen[3]
remedies for this disea
and dropsy. As a *top*
injection in gonorrhœa
of the cornea.

---

[1] *El*
[2] *W*
[3] *Tr*

A solution of gr. xv. in ℥ij. water has been successfully used as a wash in prurigo genitalium.

ADMINISTRATION.—It may be administered internally in doses of from half a grain gradually increased to five or more grains. It is usually exhibited in the form of a pill, rarely in that of a solution.

1. PILULÆ CUPRI AMMONIATI, E.; *Pills of Ammoniated Copper.* (Ammoniated Copper in fine powder, *one part;* Bread Crumb, *six parts;* Solution of Carbonate of Ammonia, *a sufficiency.* Beat them into a proper mass; and divide it into pills, containing each half a grain of ammoniated copper).—Dose from one to five or six pills in the before-mentioned cases.

2. CUPRI AMMONIO-SULPHAS, D.; *Ammonio-Sulphate of Copper.*—Take of Sulphate of Copper, ℥ij.; Commercial Sesquicarbonate of Ammonia, ℥iij.:—Rub them together in a porcelain mortar until the effervescence has ceased; then roll up the residue in bibulous paper, and place it on a porous brick. When dry let it be enclosed in a bottle furnished with a well-fitted stopper.

3. LIQUOR CUPRI AMMONIO-SULPHATIS, L.; *Cupri Ammoniati Solutio*, E.; *Solution of Ammoniated Copper; Aqua Sapphirina.* (Ammonio-sulphate of Copper, ʒj.; Distilled Water, Oj. Dissolve the Ammonio-sulphate of copper in the water, and strain. *L. E*).—This solution is applied to indolent ulcers as a stimulant and detergent; and, when diluted, to the eye, to remove slight specks of the cornea.

166. CUPRI ACETATES.—ACETATES OF COPPER.

Five compounds of oxide of copper and acetic acid are known; of these, three are subsalts, and two are neutral.

Subacetates...	Trisacetate of Copper	$3CuO,\bar{A},2HO$
	Diacetate of Copper, hydrated (*blue verdigris*)	$2CuO,\bar{A},6HO$
	Subsesquiacetate of Copper, crystallised	$3CuO,2\bar{A},6HO$
Acetates	Acetate, crystallised (*crystallised verdigris*)	$CuO,\bar{A},HO$
	Acetate, crystallised, penthydrated	$CuO,\bar{A},5HO$

L. Gmelin enumerates, on the authority of Berzelius, another compound, the formula of which is $48CuO,\bar{A},12HO$.

1. Cupri Subacetates.—Subacetates of Copper.

HISTORY.—Hippocrates employed *verdigris*, which he terms χαλκοῦ ἰὸς, or *rust of copper*, in diseases of the eye, and as an astringent in hemorrhoids.[1] Theophrastus,[2] Dioscorides,[3] and Pliny,[4] describe the method of procuring it. The Romans called it *ærugo*, the term by which it is now known in the Materia Medica of the London Pharmacopœia. It is usually termed *diacetate of*

---

[1] *Opera*, ed. Fœs. 635, 636, and 894.

[2] *De Lepidibus.*

[3] Lib v. cap. xci.

[4] *Hist. Nat.* xxxiv.

copper ; but this na
subsesquiacetate m
though more accurat
acetates composing

PREPARATION.—A
allowed to ferment w
plates of copper : ac
oxidized by the com
days the plates are c
and exposed for a mo
with more oxide of
packed in leathern sa
by sprinkling plates
prepared by exposing
method now practise
woollen cloth steepe
superficially covered
the operation repeate
in sacks weighing fro

PROPERTIES.—It c
bluish-green colour
The taste is astringen
more disagreeable tha
resolves it into a solul

Characteristics.—
acetic acid, which is
tube it gives out aceti
digris be boiled in dis
contain copper by its c
compounds.

COMPOSITION.—*Bl*
verdigris consists of t
sition of these salts is

	At
Oxide of Copper	2
Acetic Acid	1
Water	6
	1

PURITY.—The follov
the British Colleges :—

Is partly soluble in wate
of heat. Ammonia added i

---

[1] Du
[2] Bra
[3] Bei

It is dissolved in a great measure by muriatic acid, not above five per cent. of impurity being left.—*Ph. Edin.*

Chalk and sulphate of copper are employed to adulterate verdigris. The first effervesces with the mineral acids. The characteristics of the second have been already pointed out.

PHYSIOLOGICAL EFFECTS.—The action of verdigris on the system is very similar to that of the other preparations of copper: thus, taken in small and repeated doses, it operates on the nervous system, and is called tonic and antispasmodic; in larger doses it acts as an emetic; and, in excessive doses, it is a powerful poison, producing both gastro enteritis (indicated by vomiting, purging, and pain,) and an affection of the nervous system (marked by insensibility, convulsions, and even tetanus).

USES.—Verdigris, when taken into the stomach, being variable and dangerous in its operation, is never administered internally. It was formerly employed in obstinate syphilis, when mercurials failed.

The *powder* is sometimes employed as an escharotic. It is sprinkled over foul and indolent ulcers, or, when mixed with powdered savin, is applied to destroy venereal warts. When used for the latter purpose it rarely fails.

1. CUPRI SUBACETAS PRÆPARATUM, D.; *Prepared Verdigris.* (Take of Subacetate of Copper a convenient quantity: Reduce it to a powder by careful trituration in a porcelain mortar, and separate the finer parts for use by means of a sieve.)—The object of this process is to obtain a very fine powder. The water, however, effects a chemical change on the verdigris, and converts it into a soluble acetate and an insoluble trisacetate.

2. LINIMENTUM ÆRUGINIS, L.; *Oxymel Cupri Subacetatis; Mel Ægyptiacum; Unguentum Ægyptiacum; Oxymel Æruginis.* (Verdigris, powdered, ℥j.; Vinegar, f℥vij.; Clarified Honey, ℥xiv.; Dissolve the verdigris in the vinegar, and strain the solution through linen; afterwards, the honey being added, boil down to a proper consistence.)—Stimulant, detergent, and slightly escharotic. It is applied by means of a camel's hair pencil to venereal ulcers of the throat, as well as to other indolent ulcers.—Diluted with water it is employed as a gargle.

By keeping, this preparation undergoes chemical change: the honey becomes coloured, and its crystallisable sugar is converted into uncrystallisable saccharine matter, while the subacetate of copper is reduced to the form of minute granules of metallic copper.[1]

3. UNGUENTUM CUPRI SUBACETATIS, D.; *Unguentum Æruginis*, E. *Ointment of Verdigris.* (Take of Prepared Subacetate of Copper, ʒss.; Ointment of White Wax, ʒviiss.:—Triturate the subacetate of copper with the ointment until they are intimately mixed, *D.*—Resinous Ointment, ℥xv.; Verdigris, in fine powder, ℥j.: Mix. *E.*)—Stimulant and mildly escharotic. It is used as an application to foul ulcers, as venereal ulcers of the throat and ulcerated tonsils in scarlatina; it is also employed in ophthalmia tarsi; as a cure for the obstinate forms of ringworm; and as an application to corns. [Mr. John Harley[2] states that in the preparation of this liniment according to

---

[1] Mr. E. Quekett, *Pharmaceutical Journal*, vol. iv. p. 563, 1845.

[2] *Pharm. Journ.* 1851–52, p. 337.

the Pharmacopœia, the copper is precipitated as a suboxide, a si
mel remaining. Out of five samples obtained from different sources
contained the slightest trace of copper. In order to succeed, the te
must not reach the boiling point; a fine green solution is thus obtai
taining the proper quantity of acetate of copper.—ED.]

2. Cupri Acetas.—Neutral Acetate of Copper.

Formula $\mathrm{CuO},\bar{\mathrm{A}},\mathrm{HO}$. *Equivalent Weight* 100.

This salt, commonly termed *distilled* or *crystallised verdigri*
crystallisata), and sometimes *flos æruginis*, is met with in t
crystallised on sticks. It is usually prepared by dissolving common
in acetic acid, and crystallising. The crystals are oblique rhomb
They consist of one equivalent of oxide of copper, one equivalent
acid, and one equivalent of water. This salt is completely soluble
by which it is distinguished from common verdigris. In most other
it agrees with the latter. The bluish white precipitate obtained by
solution of the neutral acetate of copper to a solution of albumen c
albumen 90·81, and *di-acetate of copper* 9·19. It is soluble
of solution of either acetate of copper or of albumen.[1] It is rarely
in medicine. Its effects and uses are similar to those of the subacet
formerly served for the preparation of concentrated acetic acid. It
also, as a pigment.

ORDER XXIX. MERCURY AND ITS COMPOUN

167. HYDRARGYRUM.—MERCURY OR QUICKSI

Symbol Hg. *Equivalent Weight* 100.[2]

HISTORY.—No mention is made of quicksilver in the Old Testam
does Herodotus allude to it. From this we might infer that both th
Hebrews and Egyptians were unacquainted with it. But we are tel
authority of an Oriental writer, that the Egyptian magicians, in their

---

[1] Lassaigne, *Journal de Chimie Méd.* t. vi. 2de sér. p. 305.

[2] "Considerable difference of opinion has prevailed respecting the equivalent or atomi
mercury, arising out of the different views which have been adopted in reference to the c
of its *oxides*, of which there are two,—a grey and a red, and both of them salifiable. If
considered as a *protoxide*, and the red a *binoxide*, then the number 200 will represent
if, on the other hand, it be assumed that the red oxide be the *protoxide*, and the grey a
dioxide, the number 100 must be assumed as the weight of the atom of mercury; an
strong grounds in favour of the latter view; for the grey oxide is very unstable, and
therefore, in the characters of a true protoxide; whereas the red oxide is comparatively
and stable, and it is eminently *basic*, verging even upon alkalinity in its properties; and
these considerations, we add the evidence deduced from the connection between the speci
mercury and its atomic weight, we are, I think, forced to regard the red oxide of merc
protoxide, and notwithstanding the inconvenience that will occasionally ensue in refere
application of this number to some of the mercurial compounds, to represent the metal by th
100. (100, Gmelin and Thomson; 101·266, Berzelius; 100·04, Erdmann and Marchand
Graham; 202, Gregory)."—Brande's *Manual of Chemistry*.

to imitate the miracles of Moses, employed wands and cords containing mercury, which, under the influence of the solar heat, imitated the motion of serpents.[1] Both Aristotle and Theophrastus[2] mention Ἄργυρος χυτός (*Argentum liquidum*): and the first of these naturalists says that Dædalus (who is supposed to have lived about 1300 years before Christ) communicated a power of motion to a wooden Venus by pouring quicksilver into it. We are also told that Dædalus was taught this art by the priests of Memphis. Pliny[3] and Dioscorides[4] speak of mercury, and the latter writer describes the method of obtaining it from cinnabar.

Mercury was first employed medicinally by the Arabian physicians Avicenna and Rhazes; but they only ventured to use it externally against vermin and cutaneous diseases. We are indebted to that renowned empiric, Paracelsus, for its administration internally.

SYNONYMES.—The names by which this metal has been distinguished are numerous. Some have reference to its silvery appearance and liquid form: as ὑδράργυρος, *hydrargyrus* and *hydrargyrum* (from ὕδωρ, *aqua*, and ἄργυρος, *silver*); others to its mobility and liquidity, as well as its similarity to silver such as *argentum vivum*, *aqua argentea*, *aqua metallorum*, and *quicksilver*. It has been called *mercury*, ☿, *mercurius*, after the messenger of the gods, on account of its volatility.

NATURAL HISTORY.—Mercury is comparatively a rare substance. It is found in the metallic state, either pure (*native* or *virgin mercury*), in the form of globules, in the cavities of the other ores of this metal, or combined with silver (*native amalgam*). Sulphuret of mercury (*native cinnabar*) is the most important of the quicksilver ores, since the metal of commerce is chiefly obtained from it. The principal mines of it are those of Idria in Carniola, and Almaden in Spain. The latter yielded 10,000 lbs. of cinnabar annually to Rome in the time of Pliny.[5] Subchloride of mercury (*mercurial horn ore* or *corneous mercury*), iodide of mercury, and seleniuret of mercury, are also found native. Traces of this metal have also been met with in common salt, during distillation with sulphuric acid, by Rouelle, Proust, Westrumb, and Wurzur.[6]

PREPARATION.—The extraction of quicksilver is very simple. In some places (as in the Palatinate and the Duchy of Deux-Ponts) the native cinnabar is mixed with caustic lime, and distilled in iron retorts. The products are sulphuret of calcium, sulphate of lime, and mercury, which distils over. $4HgS+4CaO=2CaS+CaO,SO^3+4Hg$. At Almaden the ore is roasted, by which the sulphur is converted into sulphurous acid, and the mercury volatilised: $HgS+2O=Hg+SO^2$. At Idria a modification of this process is followed.[7]

COMMERCE.—Quicksilver is imported in cylindrical wrought-iron bottles (holding from 60 lbs. to 1 cwt.), the mouth of each being closed by an iron screw; and also in goat-skins, two or three times doubled. The quantities

---

[1] D'Herbelot, *Bibliothèque Orient.* art. *Mousa.*

[2] *De Lapidibus.*

[3] *Hist. Nat.* lib. xxxiii.

[4] Lib. v. cap. cx.

[5] *Hist. Nat.* xxxiii.

[6] Gmelin, *Handb. d. Chemie*, i. 1289.

[7] Dumas, *Traité de Chimie*, iv. 205.

imported in the yea
metal was brought i
papers :[1]—

Spain and the Bal
Gibraltar ………
Italy and the Itali

[The quantity tak
328,563 lbs.—Ed.]
The iron bottles i
preparation of oxyge
In 1844 a quant
China in little bamb
[We are indebted
regarding the comm
The gold and sil
tities of quicksilver
from time immemo
sequently indirectly
1831, to contract fo
namely Messrs. N.
rose from one shillin
1849. In the latt
and soon began to
the United States,
siderable extent, so a
to two shillings and
The total importat
silver, amounted in
an average of 1,805,
same ten years, 292,

The impo

The quality suppli
the New World seem
excepting in regard t
duce of Almaden,
cylindrical wrought-ir
screw, each containi
making 76 pounds E
importers is on an a

---

[1] *Statement of the Impor*
[2] *Pharm. Journ.* vol. iii.
[3] [In a former edition it
We have good authority for
The high price of mercury
received since 1844.—Ed.]

4 pounds per 104 pounds, and 1 pound draft being allowed, and the tare being fixed at 18 pounds, while the real tare averages 16 to 17 pounds.

The *Austrian* quicksilver, being the produce of Idria, in Carniola, serves chiefly to supply the German markets, and is but very seldom imported into England, and then by the way of Trieste. It is packed into barrels containing two double goat-skins, each skin containing 50 pounds Vienna weight, the skins being tied by machinery into the shape of bags, by strong cords. This package is both clumsy and dangerous. The yield of Idria is very much less than that of Almadea.[1] The quicksilver mines of Tuscany have only been worked in recent periods, and are situated at Monte Amiato, Val di Castello, and Levigliano. They belong to four companies, and have in the best years produced only about 120,000 pounds, while in 1853, in consequence of the low price of quicksilver, they were only worked to the extent of about 40,000 pounds. China is said to produce much quicksilver, but only one importation from that country is known to have taken place, namely in 1844, the period referred to by the author, when the price of four shillings and sixpence brought it to this market. It consisted of 160 bamboo bottles, or rather boxes, covered with cemented linen cloth, each holding about 60 pounds net. The Californian quicksilver is packed, like the Tuscan, into old Spanish bottles, which are bought up in this and other markets for that purpose. The bulk of the yield is retained for their own gold mines, or shipped to other parts of America.—ED.]

PROPERTIES.—At ordinary temperatures quicksilver is an odourless, tasteless, liquid metal, having a whitish colour, like silver or tin. Its sp. gr. is 13·5 or 13·6. When intimately mixed with pulverulent or fatty bodies, it loses its liquid character, and it is then said to be *killed*, *extinguished*, or *mortified*. When cooled down to −38·66° F., it freezes, and crystallises in needles and regular octohedrons. In this state it is ductile, malleable, and tenacious; and its density is 15·391. At 662° F. it boils and produces an invisible elastic vapour, whose sp. gr. is 6·976. Mr. Faraday[2] has shown that at common temperatures, and even when the air is present, mercury is always surrounded by a mercurial atmosphere; and, according to Stromeyer, at from 140° F. to 160° F., mercury, when mixed with water, is volatilised in considerable quantities. The presence of lead or tin retards the distillation of mercury, while that of platinum appears to accelerate it.

Characteristics.—In its *metallic* or *reguline* state, mercury is distinguished by its liquidity at common temperatures, and by its volatility. When invisible to the naked eye, and in a finely divided state, it may be readily detected by the white stain (called by workmen *quickening*) communicated to gold and silver. Mercurial vapour may be detected by exposing gold or silver to its influence. If mercury be in combination with other metals, and the tests now mentioned be not applicable, we may dissolve the suspected substance in nitric acid, and proceed as for the mercurial salts.

The *mercurial compounds*, when heated with potash or soda, or their carbonates, yield globules of metallic mercury, which may be recognised by the properties already described. If calomel (Hg^2Cl) be the mercurial com-

---

[1] The yield of Idria varies according to the demand for the article, but it may be stated to be on an annual average of 370,000 pounds English.

[2] *Quarterly Journal of Science*, x. 354.

pound examined, th
Hg^2+O+CO^2. S
contact with a piec
leave a silvery stain
redness. With nit
$Hg^2O,NO^5+Cu=$
selves insoluble in
and the copper test
in calomel, vermilio
nised. Sulphurette
precipitate (*sulphu*
Solutions of the
a grey or black prec
potassium, a greenis
Solutions of the
yellow or reddish pr
of potassium, a scarl
PURITY.—The pu
mobility. Mechani
detected, and may b
through a small hol
of lead, tin, zinc, or
the metal tarnishes
serving a spherical f
in an earthen retort.

Its specific gravity is
rolled about on a she
Ph. Lond.

Entirely sublimed by
pure sulphuric acid ag
residuum.—*Ph. Ed.*

PHYSIOLOGICAL E
Mercurial vapours ar
β. *On Animals.*-
and Gaspard,[5] it ap
in the small vessels
tant. Thus, if throv
on examination after
the lungs, in each of
γ. *On Man.*—So
mercury when swal
that it is innocuous.
metallic state it is in
mentary canal, and i
Brasavola, declared it

---

[1] De C
[2] *Phil*
[3] Bedd
[4] Quot
[5] Mag
[6] *Mém*

time two pounds daily without injury; and I could refer to the experience of many others who have seen it employed in obstruction of the bowels, without proving noxious; but the fact is so generally known and admitted, as to require no further notice. In some instances, however, it has acted powerfully, more especially where it has been retained in the bowels for a considerable time; no doubt from becoming oxidised. Thus, Zwinger[1] states that four ounces brought on profuse salivation four days after swallowing it. Laborde[2] also tells us, that a man who retained seven ounces in his body for fourteen days was attacked with profuse salivation, ulceration of the mouth, and paralysis of the extremities; and other cases of a similar kind might be quoted. Dr. Christison considers the question set at rest by the Berlin College of Physicians, and that the metal is innocuous.

Applied externally, liquid mercury has sometimes produced bad effects. Dr. Scheel has related a fatal case, attended with salivation, brought on from wearing at the breast during six years a leather bag, containing a few drachms of liquid mercury, as a prophylactic for itch and vermin.[3]

The injurious effects of *mercurial vapours* when inhaled or otherwise applied to the body, have been long known. They are observed in water-gilders, looking-glass silverers, barometer-makers, workmen employed in quicksilver mines, and in others exposed to mercurial emanations. In most instances an affection of the nervous system is brought on, and which is indicated by the *shaking palsy* or *tremblement mercuriel* (*tremor mercurialis*), which is sometimes attended with stammering (*psellismus metallicus*), vertigo, loss of memory, and other cerebral disorders, which frequently terminate fatally. The first symptom of shaking palsy is unsteadiness of the arm, succeeded by a kind of quivering of the muscles, which increases until the movements become of a convulsive character. In all the cases (about five or six in number) which have fallen under my notice, the shaking ceased during sleep. I have not seen the least benefit obtained in confirmed cases by remedial means, although various modes of treatment were tried. This is not in accordance with the experience of Dr. Christison, who says the tremors "are cured easily though slowly." If the individual continue his business, other more dangerous symptoms come on, such as delirium or epilepsy, or apoplexy (*apoplexia mercurialis*); and ultimately death takes place.

In some instances, salivation, ulceration of the mouth, and hæmoptysis, are produced by the vapour of mercury. The following remarkable case is an instance in point. In 1810, the Triumph man-of-war, and Phipps schooner, received on board several tons of quicksilver, saved from the wreck of a vessel near Cadiz. In consequence of the rotting of the bags the mercury escaped, and the whole of the crews became more or less affected. In the space of three weeks 200 men were salivated, two died, and all the animals, cats, dogs, sheep, fowls, a canary bird,—nay, even the rats, mice, and cockroaches, were destroyed.[4] As metallic mercury in the liquid state is not active, it has been thought that mercurial vapour must also be inactive. Thus, Dr. Christison thinks that the activity of the emanations arises from the oxidation of the metal before it is inhaled. I believe, however, with Buchner,[1] O others, that metallic mercury, in the finely divided state in which it n as vapour, is itself poisonous.

---

[1] *Miscell. Curios. Decur.* 2nda Ann. 6, 1688.

[2] *Journ. de Méd.* i. 3.

[3] Richter, *Ausführ. Arzneim.* Supplem. Bd. 615.

[4] *Edinb. Med. and Surg. Journ.* xxvi. 29.

2. Of Mercurial Compounds.—Probably all the mercurial compo more or less noxious. The only doubtful exception to this staten the case of the sulphurets of this metal, which, according to Orfila,[3]

α. *Local effects.*—For the most part, the local action of the compounds may be regarded as alterative, and more or less irritant of the preparations (as corrosive sublimate, and the nitrates) are caustics. The suboxide and calomel are very slightly irritant only Mr. Annesley[4] asserts, from his experiments on dogs, and his experi it in the human subject, that the latter substance is the reverse of ar in other words, that when applied to the gastro-intestinal mer diminishes its vascularity. But I suspect some error of observation

β. *Remote effects.*—In *small* and *repeated doses*, the first obvi of mercurials is an increased activity in the secreting and exhaling s This is particularly observed in the digestive organs; the quantity of mucus, of bile, of saliva, of mucus of the mouth, and probably of p liquid, being augmented. The alvine discharges become more liq contain a larger proportion of bile. The operation of the medicine stop here: the pulmonary, urino-genital, and conjunctival membranes moister, the urine is increased in quantity, the catamenial discharge times brought on, the skin becomes damper, and at the same time so that mercury seems to promote the excretions generally. The abs lymphatic system seems also to be stimulated to increased activity frequently observe that accumulations of fluids in the shut sacs (as th the peritoneum, the arachnoid, and synovial membranes) diminish in and in some cases rapidly disappear, under the use of mercury. At time, also, glandular swellings, enlargements, and indurations of vario are dispersed. (For some other observations respecting the *liqu* action of mercury, see *ante*, pp. 179 and 188.)

When our object is to obtain the *sialogogue* operation of mercu give them in *somewhat larger doses.* To a certain extent the effect same as those already mentioned, but more intense. Of all the se none are so uniformly and remarkably augmented as those of the mucous of the mouth and the salivary glands; and the increased secretion i panied with more or less tenderness and inflammation of these parts, t constituting what is termed *salivation* or *ptyalism* (*salivatio, pty sialismus*). The first symptoms of this affection are slight tendern tumefaction of the gums, which acquire a pale rose colour, except at t surrounding the teeth, where they are deep red. Gradually the mouth exceedingly sore, and the tongue much swollen; a coppery taste is pe and the breath acquires a remarkable fetidity. The salivary glan become tender and swollen; the saliva and mucus of the mouth flow abu sometimes to the extent of several pints in the twenty-four hours.

---

[1] *Toxicologie.*

[2] *Toxicol. Gén.*

[3] *Arch. Gén. de Méd.* xix. 330.

[4] *Diseases of India.*

this state, the fat is rapidly absorbed, and the patient becomes exceedingly emaciated. The blood, when drawn from a vein, puts on the same appearance as it does in inflammatory diseases.

The quantity of saliva and buccal mucus discharged by patients under the influence of mercury, varies according to the quantity of the medicine employed, and the susceptibility of the patient. Formerly salivation was carried to a much greater extent than it is at the present day. Thus Boerhaave[1] considered that a patient should spit three or four pounds in twenty-four hours, and Turner[2] says from two to three quarts are "a good and sufficient discharge." Modern experience has shown that all the good effects of mercurials may be gained by a very slight affection of the mouth. Several analyses have been made of saliva from patients under the influence of mercury. Fourcroy, Thomson, Bostock, and Devergie, failed to detect the least trace of mercury in it. But some other persons have been more successful, as will be hereafter mentioned. The following are the constituents of saliva during mercurial ptyalism according to Dr. Thomson:[3]—

Coagulated Albumen	0·237
Mucus, with a little Albumen	0·367
Chloride of Sodium	0·090
Water	99·286
	100·000

It was an opal fluid, having a sp. gr. of 1·0038, and by standing deposited flakes of coagulated albumen. The nitrates of lead and mercury produced copious precipitates with it, but the ferrocyanide of potassium and the infusion of galls had no effect on it. Dr. Bostock[4] found the saliva discharged under the influence of mercury to differ from that of the healthy state in being less viscid, and in containing a substance analogous to coagulated albumen,[5] such as it exists in the serum of the blood; so that it would seem the mercurial action alters the secretion of the salivary glands, and makes it more analogous to the exhaled fluids of the serous membranes. In Simon's *Animal Chemistry*, several analyses of the saliva from patients under the influence of mercury are given. In all of these there was an increase in the amount of the solid constituents. I have tested the urine of several patients in a profuse state of salivation without having detected a trace of albumen in it.

The effects of mercury hitherto described are such as are frequently produced for the cure of diseases; but occasionally other phenomena present themselves in individuals who have been subjected to the influence of this metal, and which have been considered as constituting a peculiar malady, to which the name of *mercurial disease* (*morbus mercurialis*, *hydrargyriasis* seu *hydrargyrosis*, and *cachexia mercurialis*) has been given. The *pseudo-syphilis* or *cachexia syphiloidea* of some writers, is supposed to be syphilis more or less modified by the mercurial disease.[6] The following are the ill

---

[1] *Aphorismi.*

[2] *Practical Dissertation on the Venereal Disease*, 1737.

[3] *Annal. of Phil.* vi. 397.

[4] *Medico-Chirurg. Trans.* xiii. 78.

[5] For some interesting observations on the conversion of albumen into mucus by the action of alkalies and various salts, see Brande, in the *Phil. Trans.* for 1809; Pearson, in ditto, for 1810; Dr. B. G. Babington, in *Guy's Hospital Reports*, vol. ii.; and Dr. G. Bird, in ditto, vol. iii.

[6] See some extraordinary cases of the combined effects of syphilis and mercury, in the *Lancet* for 1832-33, vol. ii. p. 357.

natural functions much
violent exertion of the an

2. EXCESSIVE SALIVAT
I have already noticed m
cure of diseases. But it
mercury, or from some
becomes violently affecte
to such an extent that it
eating or speaking; the s
mercurialis), and the saliv
pounds are said to have b
slough, the teeth loosen
takes place. During this
and, if no intermission
muscular system come
repeatedly seen inflammat
by a few grains of calomel

A very frequent conse
ulceration and sloughing,
the anterior arches of the
mouth, except to a very
case (that of a female) it
liver complaint. The pati
Several operations have be
freely divided, but the reli
four years of age) it was
have elapsed since, the pat
the jaws by the loss of the

Non-mercurial salivation.
as iodine, iodide of potassi
the preparations of gold, an
salivation sometimes arises
mostly females. The great
taken medicine of any kin
by Dr. Christison[3] and by
pregnancy, decayed teeth, s
instances the cause cannot

It is sometimes a matt
non-mercurial ptyalism. Th

excretion of saliva; remarkable fetor of the breath (usually termed mercurial fetor); brassy or coppery taste, and tongue generally swollen. These symptoms may be followed by ulceration and sloughing. But all the same phenomena may exist when no mercury has been taken. Even the so-called mercurial fetor of the breath is not a peculiar effect of this metal.

But the disease which is most likely to be mistaken for the effects of mercury, is gangrene of the mouth, commonly called *cancrum oris*.[1] This usually, but not invariably, occurs in children. It consists of ulceration, followed by gangrene, of the inside of the cheek or lips, and is attended with a copious secretion of offensive saliva. Mercurial ptyalism may sometimes be distinguished from cancrum oris by the peculiar odour of the breath and the salivation preceding the ulceration and sloughing; and by the gums, salivary glands, and tongue, being tumefied and inflamed. But these symptoms are by no means to be relied on, as they may also attend cancrum oris; and it must be admitted, therefore, that the two affections closely resemble each other.[2] The following is a remarkable case of gangrene of the mouth occurring in the adult, and simulating the effects of mercury:—

A man affected with rheumatism sent to a surgeon for advice, who, without seeing him, prescribed some pills, one of which was to be taken thrice daily. At the end of the week, his rheumatism not being relieved, he sent his wife again to the surgeon, who ordered the pills to be repeated. Another week elapsed, when the patient requested Mr. W. H. Coward, surgeon, of the New North Road, Hoxton, to see him; to whom I am indebted for part of the particulars of this case. Mr. Coward found his patient with the following symptoms: fever, great prostration of strength, sore throat, rheumatic pains in the wrist, profuse ptyalism, more than a pint of saliva being discharged per hour, with the breath having the "mercurial" odour; and on the inner side of the right cheek a foul ulcer. He ascribed his present condition to the pills, as he had no sore mouth until after taking them. On cutting one of the pills, it was observed to have a light brown colour, and the odour of opium: hence it was supposed that they were composed of calomel and opium. Purgatives, tonics, and gargles of chloride of soda, were used without avail; and, after some days, Mr. Coward requested me to see the patient. I found him in the following condition: right side of the face swollen and slightly red; gums swollen, red, and ulcerated; breath horribly offensive, its odour not distinguishable from that called mercurial. On the inner side of the cheek, near the orifice of the parotid duct, there was a slough about the size of a sixpenny piece; salivation most profuse,—in fact, the saliva flowed in a continued stream from his mouth; over the body were observed a few petechiæ. Notwithstanding the means employed, the man became worse, the sloughing gradually increased until the whole of the right cheek became involved, and in about a week from my first visiting him he died. A day or two before his death, I ascertained from the surgeon who had prescribed the pills that they contained Dover's powder, and not an atom of any mercurial preparation.

3. MERCURIAL PURGING (*Diarrhœa mercurialis*).—Violent purging is a very frequent consequence of the use of mercury. It is frequently attended with griping, and sometimes with sanguineous evacuations. In some cases there is fulness of the left hypochondrium, burning pain and tenderness of the region of the pancreas, and the evacuations are frothy, whitish, tough, and often greenish, at least in the commencement, from the intermixed bile. These symptoms may fairly be referred to an affection of the pancreas analogous to that of the salivary glands. Dieterich[3] terms it *ptyalismus pancreaticus mercurialis* (*diarrhœa salivalis, sialorrhœa alvina, ptyalismus abdominalis*).

4. UROBRHŒA MERCURIALIS.—Excessive secretion of urine, from the use of mercury, is very rare. Two cases are recorded by Schlichting.[4]

5. HIDROSIS MERCURIALIS.—Profuse sweating is another occasional effect of mercury.

6. SKIN DISEASES.—Several forms of skin diseases, both acute and chronic, have been regarded as part of the ill effects of mercury.

a. Eczema mercuriale, Pearson (*Erythema mercuriale*, Spens and Mullins; *Lepra mer-*

---

[1] See an excellent account of this disease, by Dr. H. Green, in Costello's *Cyclopædia of Practical Surgery*, vol. i.

[2] In the *Lond. Med. Gaz.* Aug. 28, 1840, is the report of an inquest held on the body of a child who died of cancrum oris, but whose death was alleged to have been caused by mercury.

[3] *Op. cit.*

[4] *Ephemerid*, A. C. L., Nurembergæ, 1748, t. viii. Obs. viii. p. 25, quoted by Dieterich, *op. cit.*

curialis, Stokes and M
Lagneau; *Spilosis mer*
progress of a mercurial
saw forty-three cases i
confesses, that in twen
two cases of it. The
have been mistaken for
skin, and a sensation o
by febrile disorder. I
the included serum bec
accompanied by tumef
mation; but in some c
surface; and when this
the hair and nails fall o
usually some affection
the præcordia.

β. *Miliaria mercuria*
and Dieterich, apparent

γ. *Chronic skin disea*
quences of the use of m
but considerable doubt
remedy, or of the diseas
of system. *Herpes præ*
mercury,[2] and his opinic
occurs when no mercury
mercurialis of Dieterich

7. INFLAMMATION OF
ascribed by some writer
to produce these disease
be doubted, but *post hoc*
to as states of congesti
(from συμφόρησις, *an acc*

The inflammation of t
oculi mercurialis, Dieteri
bably be referred to som
the cornea; that it some
and is commonly regard

The mercurial iritis (
rheumatico-mercurialis, J
arising from some other
retinæ oculi mercurialis, I

An inflammation of th
curialis; *symphoresis fau*
after the use of mercury,
appear after the employm

Inflammation of the
(*symphoresis periostei mer*
is rarely or never seen a
the cure of a venereal a
referred[9]

8. HYPERTROPHIES (*H*

---

[1] *Observ. on the Hydrar*
[2] Bateman, *Pract. Syno*
[3] *Op. cit.*
[4] Rust's *Magazin*, 1830.
[5] *Surgical Essays*, i. 59.
[6] Mackenzie, *On Disease*
[7] Colles, *Pract. Observ.*
[8] Dieterich, *op. cit.* 273.
[9] Mr. Lawrence, *Lecture*

and mesenteric glands (*adenophyma inguinale, mercuriale; ad. axillare merc.; ad. mesaraicum merc.* Dieterich), as well as some of the secreting glands, viz. the parotid glands, the pancreas, the testicles, and liver (*adenophyma parotideum merc.; ad. pancreaticum merc.; ad. testiculi merc.; hepatophyma merc.*), and condyloma and ganglion (*condyloma et ganglion mercuriale*, Dieterich), have been ascribed by some[1] to the use of mercury, but, as I believe, on insufficient grounds.

9. Ulceration and Sloughing.—Ulceration of the mouth is a well-known effect of mercury. Ulceration of the throat is likewise a consequence of the use of this mineral (*mercurial ulcerated throat*, Mathias; *mercurial sore throat*, Bacot[2]). Sloughing of the same parts may also be induced. It is well known that venereal sores (especially those called phagedenic) at times assume a sloughing disposition, in consequence of the improper use of mercury.[3] Ulceration of the fibrous membranes (*ulcus membranæ fibrosæ mercuriale* and absorbent glands (*ulcus glandulorum mercuriale*) has been ascribed to the use of mercury.[4]

10. Neuroses mercuriales.—Various symptoms, indicating a disordered condition of the nervous system, are met with in persons who have been exposed to the baneful influence of mercury: such as wandering pains (*neuralgia mercurialis*); a tremulous condition of the muscular system (*tremor mercurialis*), sometimes accompanied with stammering (*psellismus metallicus*), and occasionally terminating in paralysis (*paralysis mercurialis*) epilepsy or apoplexy (*apoplexia mercurialis*). To these Dieterich adds asthma (*asthma mercurialis*), of which he only saw one case, amaurosis (*amaurosis mercurialis*), and hypochondriasis (*hypochondriasis mercurialis*). Of these, the best known is the shaking palsy (*tremor mercurialis; tremblement mercuriel*), a remarkable affection, which has been already noticed.

11. Cachexia (*Cachexia mercurialis*).—This condition is characterised by disorder of the digestive organs, loss of appetite, wasting, incapability of much exertion, with increased secretion from all the organs, especially from the salivary glands.[5]

The foregoing are the most important of the ill effects ascribed to the use of mercury. As I have already stated, some of them ought probably to be referred to other causes, and not to the use of this mineral; but as doubt must necessarily be entertained on this point, I have thought it more advisable to mention them. The student will find some pertinent observations concerning them, in a paper by Dr. Musgrave,[6] and in Dr. Currie's pamphlet.[7]

In excessive doses: acute poisoning.—When *large doses* of some of the soluble salts of mercury have been swallowed, *gastro-enteritis* is produced. The patient complains of an acrid styptic taste in the mouth, a feeling of burning and tightness in the throat; the face is usually flushed and sometimes swollen, violent vomiting and purging (frequently of bloody matters) soon come on, the vomiting being increased by everything taken into the stomach; oftentimes there is irritation of the urinary passages, and sometimes even suppression of the urine; the pulse is small, frequent, and contracted; the respiration difficult; the extremities cold. In some cases *salivation* is produced; this seldom comes on during the first 24 hours, and is seldom delayed beyond the fourth day. Towards the termination of the case, some *disorder of the cerebro-spinal system* supervenes, such as slight drowsiness or stupor, or even coma; tremors and twitchings of the muscles, and so times even violent convulsions; in some cases paraplegia. These sympto terminate in death. Post-mortem examination discovers inflammation (its consequences) of the gastro-intestinal membrane.

---

[1] Mathias, *op. cit.*; and Dieterich, *op. cit.*

[2] *Lond. Med. Gaz.* iii. 812.

[3] Sir A. Cooper, *Lectures on Surgery*, in *Lancet*, iv. 42; Carmichael, *On Venereal Diseases*, p. 165, *et seq.* 2d edit.

[4] Dieterich, *op. cit.* p. 376.

[5] Mr. Travers (*Further Inquiry concerning Constitutional Irritation*, p. 87) says, mercurial cachexia is characterised "by irritable circulation, extreme pallor and emaciation, an acute and rapid hectic, and an almost invariable termination in phthisis."

[6] *Edinb. Med. and Surg. Journal*, vol. xxviii.

[7] *Examination of the Prejudice commonly entertained against Mercury.*

THEORY OF THE ACTION OF MERCURY.—There are many disputed poi connected with the action of mercurials, which it will be convenient to exam under this head.

1. *Absorption of mercury.*—By the external or internal use of mercury metal becomes absorbed, and is subsequently either deposited in some of solids of the body, or thrown out of the system by some of the excretories. The accuracy of this statement is proved by the following facts:—

α. *Mercury has been detected in the blood* by Zeller, Buchner, Schubarth,[2] Colson,[3] Dieterich. It appears to be in such intimate combination with this vital fluid th cannot be recognised by the ordinary tests. Destructive distillation is, in most c necessary for its detection.

β. *Mercury has been found in the secretions,* viz. in the perspiration, the saliva, gastro-intestinal secretion, the bile, the urine, and the fluid of ulcers.[4] The blacke of the skin, mentioned both by Harrold[5] and Rigby,[6] as having occurred in consequ of the use of mercury subsequent to the employment of sulphur, establishes the exist of mercury in the cutaneous transpiration. The sulphur and the mercury were thr out of the system by the skin, and immediately they were out of the sphere of the powers they entered into union and formed the black sulphuret of mercury, which deposited on the integument in a pulverulent form.

γ. *Mercury has been found in the reguline state in the organic solids,* viz. in the bo brain, liver, synovial capsules, the pleura, the humours of the eye, the cellular tissue, lungs, &c.[7] In what part of the system reduction is effected, has not been made out.

2. *The constitutional effects of mercury are consequences of absorption.* For, in the *first* place, mercurials affect the general system, whatever part of the body they may be applied, whether to the muco membranes, the cutaneous system, or the cellular tissue, or injected in the veins. *Secondly,* the action of mercurials on the system is promoted agents which augment absorption, and is checked by those which dimini absorption.

3. *After absorption, mercury effects changes in the qualities of t blood, and in the action of the whole organisation, but especially t apparatus of organic life.* Soon after salivation has been established, t blood exhibits an inflammatory crust. At a later period its colour deepens, a its coagulability is diminished; the proportion of clot, and therefore of fibri to serum becomes smaller. "The formation of albumen and mucus," sa Dieterich,[8] "sinks to that of serum; the whole organic formation of t patient is less consistent and cohesive." The same authority also tells u that under the influence of mercury the electrical condition of the bloo

---

[1] Oesterlen has shown that the globules of mercury contained in mercurial ointment bec absorbed, and he has detected them in the viscera and secretions. He also detected globules of t metal in the secretions after the use of calomel (Wunderlich und Roser's *Archiv,* ii. 4. Quoted Dr. Buchheim).

[2] Quoted by Dr. Christison, *On Poisons,* 3d edit. p. 366.

[3] *Arch. Gén.* xii. 68.

[4] Christison, Colson, and Dieterich, *op. cit.*

[5] Meckel's *Archiv,* iii. 532.

[6] *Lond. Med. Rep.* April 1837.

[7] Christison, *op. cit.;* Wibmer, *Wirkung d. Arzneim.* iii. 85; Colson and Dieterich, *op. cit.*

[8] *Op. cit.* 80.

changes from the negative (healthy) state to that of positive. According to Dr. Farre,[1] it diminishes the number of red globules of the blood. The evacuations from all the secreting and exhaling organs, especially from the mucous follicles and salivary glands, are much increased. The secretion of bile is also promoted. Dr. Wilson Philip[2] says, "mercury has a specific operation on the liver,—a power not merely of exciting its functions, but of correcting the various derangements of that function in a way which it does not possess with respect to any other organ, and which no other medicine possesses with respect to the liver." I confess I am not acquainted with any facts warranting this broad assertion. The purgative effects of mercury arise partly from the increased secretion of bile, and partly from the stimulus given to the mucous lining of the alimentary tube; more particularly to its follicular apparatus. The *nervous system* appears also to be specifically affected by mercurials. This is to be inferred partly from the effects produced in those who are subjected to the vapours of this metal, such as the shaking palsy, &c. and partly from the effects of the soluble salts, when given in enormous doses. The *heart* and *lungs* are, in some cases, remarkably affected. This was particularly observed by Sir Benjamin Brodie[3] in his experiments on animals with corrosive sublimate; as also by Smith, Orfila, and Gaspard. The affection of the *urinary organs* in poisoning by corrosive sublimate is also not to be overlooked.

4. *The nature of the influence exercised by mercury over the organism* has been a fertile source of discussion. One class of writers has regarded it as mechanical, a second as chemical, a third as dynamical.

α. *Mechanical hypothesis.*—Astruc[4] and Barry[5] fancied that mercury acted by its weight, its divisibility, and its mobility; and thus getting into the blood, separated its globules, rendered it more fluid and fit for secretion, made the lymph thinner, and overcame any existing obstructions.

β. *Chemical hypothesis.*—Some have advocated the chemical operation of mercurials, and have endeavoured to explain their curative powers in the venereal disease by reference to their chemical properties; but without success. Thus Mitié, Pressevin,[6] and Swediaur,[7] assumed that mercury acted chemically on the syphilitic poison, as acids and alkalies do on each other; while Girtanner[8] supposed that the efficacy of mercurials depended on the oxygen they contain. To both hypotheses the same objection applies; if they were true, the larger the quantity of mercury used, the more effectually would the venereal disease be cured. Now this is not found to be the case. Dr. Cullen[9] endeavoured to account for the action of mercury on the salivary glands, in preference to other organs, by assuming that it has a particular disposition to unite with ammoniacal salts, with which it passes off by the various excretions: and as the saliva was supposed to contain more of these salts than other secretions, he thus accounted for the larger quantity of mercury which passed off by these glands, and which, being in this way applied to the excretories, occasioned salivation. But the whole hypothesis falls to the ground when it is known that mercury has no "particular disposition" to unite with ammoniacal salts; and tha even if it had, other secretions are as abundantly supplied with these salts as the saliv Dr. John Murray substituted another hypothesis, but equally objectionable: mercur says he, cannot pass off by the urine, because of the phosphoric acid contained in this flui and which would form, with the mercury, an insoluble compound. It must, therefore, thrown out of the system by other secretions, particularly by the saliva, which facilitat this transmission by the affinity which the muriatic acid, the soda, and the ammonia the secretion, have for the oxide of mercury, and by which a compound soluble in wat is formed. The answer to this hypothesis is, that mercury *is* thrown out of the syste by the urine, and probably in larger quantity than by the saliva; secondly, the saliva al contains phosphatic salts, according to Tiedemann and Gmelin.

---

[1] Ferguson's *Essays on the Diseases of Women*, part i. p. 216.—"A full plethoric woman, of a purple red complexion, consulted me," says Dr. Farre, "for hemorrhage from the stomach depending on engorgement, without organic disease. I gave her mercury, and in six weeks blanched her as white as a lily."

[2] *On the Influence of Minute Doses of Mercury*, p. 14.

[3] *Phil. Trans.* for 1812.

[4] *De Morb. Ven.* ii. 149.

[5] *Medical Transactions*, i. 25.

[6] Quoted by Richter, *Ausf. Arzneim.* iv. 305.

[7] *Practical Observations on Venereal Complaints.*

[8] *Abhandl. ü. d. Vener. Krankh.*

[9] *Treat. of the Mat. Med.* ii. 446.

γ. *Dynamical hypothesis.*—Some writers have principally directed their attention to t quality of the effects induced by mercury, and have termed this mineral stimulant, sedati both stimulant and sedative, tonic or alterative. Those who assume mercury to be *stimulant* or *excitant* are not agreed as to whether one or more parts or the whole syste are stimulated, and if particular parts, what these are. Thus Hecker fixes on the ly phatic system, Schone on the arterial capillary system, Reil on the nerves.[1] The simp answer to all of them is, that other stimulants are not capable of producing the same effe on the constitution as mercury; nay, are frequently hurtful in the very cases in whi this metal is beneficial.

On the other hand, Conradi, Bertele, and Horn,[2] consider it to be a *weakening ag* or *sedative*. Hence those who adopt this hypothesis must assume that the diseases which mercury is beneficial are of a phlogistic or hypersthenic character; and th syphilis, therefore, is of this kind,—an explanation not at all satisfactory, nor consiste with facts. Of late years the sedative operation of some of the mercurial preparatio (calomel and mercurial ointment) has been assumed (particularly by our countrym practising in the East), from the circumstance that these agents allay vomiting and dia rhœa in yellow fever, cholera, and other dangerous diseases. But even admitting th mercurials do produce these effects, this is hardly a sufficient ground for denominatin them sedatives.

Some think that mercurials in *small* or moderate doses are *stimulants*, but in *excessi* doses *sedatives;* and that this sedative operation is common to all substances when em ployed in large quantities. This is the opinion of Dr. Wilson Philip.[3] Dr. Murray[4] call mercury a tonic; Vogt[5] terms it an alterative resolvent; Sundelin[6] places it among th resolvent alteratives under the designation of liquefacient (*verflüssigende*). Mr. Hunter accounts for its beneficial effects in syphilis, by saying it produces an irritation of a dif ferent kind to that caused by the venereal disease, and that it counteracts the latter b the diseased action of the living parts.

In my opinion mercury is an alterative, and a liquefacient spanæmic (see *ante*, p. 179)

USES. 1. **Of Metallic Mercury.**—Liquid mercury has been used as *chemical* agent to dissolve silver coins which have been swallowed; and as a *mechanical* agent to remove obstructions of the bowels: for exampl intussusception, or intestinal invagination. But neither theory nor experienc seems favourable to its use in the latter case; for in the greater number of case the intussusception is progressive—that is, the superior portion of the gut i insinuated into the lower portion, and therefore the pressure of the metal on th sides of the intestine cannot give relief; and even in cases of retrograde intussusception—that is, where the lower portion of the bowels passes into the upper mercury, instead of pressing the intussuscepted portion back, might push i farther on, by getting into the angle of reflection between the containing an inverted gut.[1] *Lastly*, water, which had been boiled with mercury (*aqua mercurialis cocta*), was at one time used as an anthelmintic; but if the metal be pure, the water takes up no appreciable quantity of it. Moreover, it would appear that mercury has no particular anthelmintic powers: for persons who were salivated have not been freed from their worms, and Scopoli very frequently found ascarides in the workers of the quicksilver mines of Idria.[2]

---

[1] Richter, *op. cit.* v. 306.

[4] Quoted by Richter, *op. cit.* v. 307.

[2] *Op. cit.*

[3] *Syst. of Mat. Med.*

[4] *Pharmakodynamik.*

[5] *Heilmittellehre.*

[6] *Treatise on the Venereal Disease.*

ADMINISTRATION.—When taken internally, it has been administered in various doses, from an ounce to a pound or more.

2. **Of the Preparations of Mercury.**—As *errhines* or *emetics*, mercurials are never resorted to now, though formerly the *subsulphate* was used for these purposes.

As *alteratives*, they are given in small doses in various chronic diseases; such, for example, as dyspepsia, gout, chronic skin diseases, and scrofula. Calomel is said to be less beneficial as an alterative than blue pill, on account of its more irritating action on the bowels. The *hydrargyrum cum cretâ* is an excellent alterative, especially for children.

Certain preparations of mercury (as blue pill, calomel, and the *hydrargyrum cum cretâ*) are employed as *purgatives*. They promote secretion from the mucous follicles of the intestines, from the liver, and the pancreas. They are rarely, however, used alone; being, in general, either combined with, or followed by, other cathartics (as jalap, senna, colocynth, or the saline purgatives). Thus it is a common practice to exhibit a blue pill or calomel at night, and an aperient draught the following morning: the object being to allow the pill to remain as long as possible in the bowels, in order that it may the more effectually act on the liver. Mercurial purgatives are administered for various purposes; sometimes as anthelmintics, sometimes to assist in evacuating the contents of the alimentary canal, but more commonly with the view of promoting the secretions, particularly of the liver, or of producing counter-irritation, and thereby of relieving affections of other organs, as the skin or head.

The great value of mercurials is experienced when they are given as *sialogogues*. Formerly it was supposed that the beneficial effects of mercury were proportionate to the degree of ptyalism; and thus, to eradicate particular affections, it was thought necessary to cause the evacuation of a given quantity of saliva. "I have heard," says Dr. Wilson Philip,[3] "the late Dr. Monro, of Edinburgh, state the quantity of saliva which must be discharged daily to eradicate particular affections." Modern experience has proved the incorrectness of this notion; and we now rarely find it necessary to excite a high degree of salivation; indeed, frequently it would be prejudicial, but we sometimes find it requisite to keep up this effect for several weeks, particularly in diseases of a chronic character.

a. *Production of sore mouth and salivation.*—One of the most efficacious methods of putting the system under the influence of mercury is *friction* with the *unguentum hydrargyri*; but the troublesome and unpleasant nature of the process is a strong objection to it in practice, more especially in venereal diseases, in which patients usually desire secrecy.

---

[1] Hunter, *Transactions of a Society for the Improvement of Medical and Chirurgical Knowledge*, i. 103.

[2] Bremser, *Sur les Vers Intest.* 428.

[3] *Op. cit.* p. 19.

curved glass funnel.)
half a grain of corrosi
of this strength the p
tions, however, exist t
the most convenient n
particularly of those p
and the *hydrargyrum c*

β. *Treatment before*
by antiphlogistic meas
but they are now ra
Colles[6] thinks that the
the want of them has,
disrepute—in which op
experienced in affecting
condition of the bowel
opium or vegetable ast
susceptible to the influ
presence of some dise
these cases, as they pr
the state of nausea pro
powerful nauseant. Va
facilitate its operation u
tion should be tried, an

During the time that
to the house, use warm
and regulate the state
mercurial course the ma
I think, objected to this
take place. the further u
rate the effect already p
air, use purgatives and
liquid. I have generally
lime; but in the absence
used. Dr. Watson[8] ob
gums, form the chief pa
gargle made of brandy a
of water." With regard
specific power of stoppin

---

have been strongly recommended. Sometimes sulphate of quina is administered with advantage.

γ. *Accidents during salivation.*—Occasionally, during salivation, certain effects result from mercury, which are in no way necessary or useful in a therapeutical point of view: on the contrary, some of them are highly prejudicial. Thus, sometimes, *excessive salivation, with ulceration of the gums*, takes place, as already noticed: not unfrequently *gastro-intestinal irritation* (or actual inflammation) comes on, which may require the suspension of the use of mercury, or its employment by way of inunction, or its combination with opium or vegetable astringents. I have already noticed *fever, eczema mercuriale*, the *mercurial erethysm* of Pearson, as other occasional effects. In feeble and irritable habits, mercury sometimes disposes sores to *slough*. Occasionally a kind of *metastasis* of the mercurial irritation is observed: thus, swallowing a large quantity of cold water, or exposing the body to cold and moisture, has caused a temporary cessation of salivation, attended with violent pains or convulsions, or great irritability of stomach.[1]

δ. *Curative action of salivation.*—Though no surgeon ascribes the curative action of mercury to the salivation, yet, without this effect, the curative influence is not usually observed. Hence, though the one cannot be considered to stand to the other in the relation of cause and effect, yet the two are usually contemporaneous; so that when we fail to induce some affection of the mouth, we do not observe the beneficial effects of mercury.

Having offered these general remarks on salivation as a remedial agent, I proceed to notice its use in particular diseases.[2]

α. *Fever.*—It has been said that salivation diminishes the susceptibility to the contagion of fever, whether common or specific; but that it is not an absolute preventive is shown by the fact, that patients under the full influence of mercury have caught fever and died of it, as will be found noticed by my friend Dr. Clutterbuck, in his *Inquiry into the Seat and Nature of Fever.*

---

[1] On this subject consult Colles, *op. cit.* p. 81.

[2] The following are Dr. Farre's rules for the exhibition of mercury (Ferguson, *op. supra cit.* p. 220):—

"1. Never to give mercury when there is an idiosyncrasy against it." The following case is illustrative of the danger of neglecting this advice:—

"A patient of Mr G.'s of the Borough, desired him never to give her any mercury, as that drug was a poison to her whole family, to which he, without arguing the point, at once assented. In Mr G.'s absence, the late Mr C. was consulted as to some trifling disorder of the bowels, and, not knowing the peculiarity of his patient's constitution, prescribed two grains of calomel. The next morning the lady showed the prescription to Mr C., saying that she was sure she had taken mercury, as she felt it in her mouth. In a few hours ptyalism ensued, in consequence of which she lost her teeth, her jaw exfoliated, and she ultimately, after a succession of ailments, died, in about two years."

"2. Mercury should be used in all active congestions—pyrexia, phlegmasia, phlegmon, ophthalmia, strabismus, cynanche laryngea, cynanche trachealis, pneumonia, and in all inflammatory diseases. In the adhesive stages of dysentery, in the phlegmasiæ, where there is inflammation with power, in tetanus, hemiplegia, paraplegia, neuralgia, in their states of active congestion.

"3. Mercury is hurtful, or doubtful—in the malignant or asthenic forms of pyrexia, where there is low delirium; but in phrenitis, and in that peculiar form of it, the [illegible], it is most effectual. It is hurtful in tetanus from punctured wound, and in all cases of irritable [illegible].

"In idiopathic iritis, it is as effectual as bark in ague; but in the traumatic it is [illegible], as it interferes with the closing of the vessels by adhesive inflammation: hence, in all such instances, where the orifices of vessels require to be closed, it is hurtful.

"In the hemiplegia of lesion, in asthenic paraplegia, in the neuralgia of [illegible] Pemberton was three times salivated for tic douloureux, and three times [illegible].

"It is hurtful in the inveterate forms of scrofulous ophthalmia, though useful in the early stage. It is bad in the anæmia of depletion.

"It is useful in puerperal peritonitis, and hurtful in the typhoid form of it, as also in the ulcerative stage of dysentery.

"In general it is hurtful in the suppurative stages of inflammation, and in all erysipelatous and erythematous inflammations, or those tending to gangrene. It is hurtful in all cases of pure asthenia from deficiency of red blood."

I have several
the most part,
marked local d
fatal cases of
any effect on t
affected, recov
Dr. Copland,[1]
rare. Wheth
the salivation
Dr. Graves[3] a
probable. Dr
judicious and
Macartney,[5] o
[mercury] fail
not combined
unusual prostr
fever to take
stance. It m
internally and
that calomel w
apparent acti
eighth part of
quantity was
observed, or u

The benefic
rienced in the
It has been sa
Indies its ben

β. *Inflam*
most successf
termed an *a*
Dr. Yeats,[10] I
form of disea
control, or pr
may prove in
inflammation,
irritability of
accounted for

---

[1] *Dict. of Pra*
[2] *On Yellow F*
[3] *Lond. Med.*
[4] *Op. cit.*
[5] *Treatise on*
[6] *Pract. Obser*
[7] Johnson, *On*
On the Diseases
[8] Johnson, *op.*
xxviii. 40.
[9] Duncan's *Me*
[10] Duncan's *An*
[11] *Med. Facts a*
[12] *Dissert. Usus*

secretions, or the increased activity of the absorbents caused by mercury. It is not equally serviceable in all inflammations. The *nature of the tissue*, the *structure of the organ affected*, and the *quality* or *kind* of inflammation, are points of considerable importance as affecting its use.

Thus it appears that inflammations of *membranous tissues* are those principally benefited by a mercurial plan of treatment; and more especially those in which there is a tendency to the exudation of coagulable lymph or of serous fluid,—as meningitis, pleuritis, pericarditis, and peritonitis (particularly of puerperal women). In inflammation of the lining membrane of the air-tube, but more especially in croup, or, as it is sometimes termed, plastic inflammation of the larynx, mercury is one of our most valuable remedies; and as this disease is one which terminates rapidly, no time should be lost in getting a sufficient quantity of mercury into the system. Calomel is usually employed; but when the bowels are very irritable the *hydrargyrum cum cretâ*, or even mercurial inunction, may be resorted to. In inflammation of the tunics of the eye, particularly iritis, mercury (next to bloodletting) is the only remedy on which much confidence can be placed; and we use it not merely with a view of putting a stop to the inflammatory action, but also in order to cause the absorption of the effused lymph.[1] In inflammation of the synovial membranes, mercury has been employed, and in some cases with manifest advantage. In dysentery, mercury has been extensively used, especially in warm climates. By some, calomel has been employed merely as a purgative (Jackson, Ballingall, Bampfield, and Annesley); by others, to produce its sialogogue effects (Johnson and Cunningham).

The *structure of the organ* influences the effect of mercury: at least it is well known that this mineral is more beneficial in inflammation of certain organs (especially those of a glandular structure, as the liver) than of others; and we refer it to some peculiarity in the structure of the part affected. In hepatitis of either temperate or tropical climates (particularly of the latter), mercury is advantageously employed.[2] Blood-letting, however, should be premised, particularly in the disease as usually met with in this country. In peripneumonia, more especially when hepatization has taken place, the best effects have sometimes resulted from its use: of course after the employment of blood-letting. When hepatization has taken place, Dr. Davies[3] recommends the use of blue pill and opium. In acute cases I prefer calomel and opium. In inflammation of the substance of the brain, also, mercury may be advantageously resorted to after the usual depletives.

The *nature* or *quality of the inflammation* also influences the effects, and thereby the uses, of mercury. Thus, in syphilitic inflammation, mercurials are of the greatest utility; less so in rheumatic inflammation; still less in scrofulous; and most decidedly objectionable in cancerous or scorbutic diseases. The treatment of rheumatism by calomel and opium was proposed by Dr. Hamilton,[4] and has found many supporters;[5] and, undoubtedly, when

---

[1] Lawrence, *Lectures on Diseases of the Eye*, in *Lancet*, vol. x. p. 198; Mackenzie, *On Diseases of the Eye*, 2d edit. pp. 389, 394, and 503.

[2] Sir James M'Grigor, *Medical Sketches*; Johnson, *On Tropical Climates*; Annesley, *On Diseases of India*.

[3] *Lectures on Diseases of the Lungs*, &c. p. 191.

[4] *Op. cit.*

[5] *Vide* Dr. Hope, *Lond. Med. Gaz.* xix. 815.

the febrile action
affected, calomel
able. It appears
disease, and to fa
part, unfavourabl
cases in which
ophthalmia, when
(as cancers and f

γ. Venereal d
symptoms of the
until mercury wa
that this notion i
geons,—namely,
and to Dr. Thom
may be cured wit
by the experienc
mercury exercises
any other disease
injuriously; and i
formerly met with
It is a point, ther
are best adapted f
treatment; for, i
is not to be infer
the very persons w
this mineral, give
fact is, I think, t
diseases, without t
relapses than by
rules to guide us i
treatment. Mr. C
this, on the appea
venereal disease w
the *phagedenic*, a
in one only, namel
chancre or callous
psoriasis. But it
military hospitals,
without mercury;
mercury is often a
advise the emplo
disease does not re
ment. But unles

---

[1] Dr. Macl
[2] *Med.-Chi*
[3] *Military*
[4] *On Syphil*
[5] *Ed. Med.*
[6] *Vide* Colle
[7] *On Venere*

mercury, it is, I think, advisable to affect the mouth slightly in most forms of the disease.

The circumstances which deserve attention, as affecting the use of mercury, are numerous. The following are the principal:—

αα. *Scrofula.*—Some of the worst and most intractable forms of venereal disease occur in scrofulous subjects; and in such, mercury is in general prejudicial. I have seen numerous instances of its injurious effects. One case which fell under my notice was that of a medical student, who, after three years' suffering, died; having been made much worse on two occasions by what I conceived to be the improper use of mercury, once by his own act, and a second time by the advice of the surgeon of his family. Mr. Colles,[1] however, denies the baneful influence of mercury in scrofula, and advises its use for the cure of syphilis in scrofulous subjects; but he admits that the profession generally entertain a contrary opinion.

ββ. *Condition of the primary ulcer.*—Another point deserving attention in deciding on the use of mercury, is the condition of the primary sore: if it be much inflamed, or of an irritable nature,—if it be of the kind called phagedenic, or at all disposed to slough,—mercury must be most carefully avoided, as it increases the disposition to sloughing. In one case that fell under my notice, a gentleman lost his penis by the improper use of mercury, under the circumstances just mentioned.

γγ. *Extreme debility with hectic fever.*—This condition is usually believed to contraindicate the employment of mercury. But Mr. Colles[2] asserts, "that a patient affected with secondary symptoms, even though extremely attenuated, and, as it were, melting away under the effects of hectic, can, with perfect safety and advantage, at once commence a course of mercury; by which not only shall his venereal symptoms be removed, but at the same time his general health be re-established."

δ. *Cholera.*—Writers on the spasmodic cholera, both of this country and of India, speak for the most part favourably of the effects of mercury, especially in the form of calomel. I may refer to the works of Drs. Johnson, Venables, and Hamett, and of Messrs. Annesley, Orton, and Searle, and more recently to the writings of Dr. Ayre, of Hull, in proof. I have met with no writers who attribute ill effects to it. Unfortunately those who advocate its use are not agreed as to the dose, or frequency of repetition: some advising it in small, others in large doses; some as a purgative, others as a sedative, in combination with opium; others, again, using it as a sialogogue. It is deserving of especial notice, that, when salivation takes place, the patient in general recovers. Dr. Griffin,[3] however, has shewn that this is not invariably the case. (For further information on the use of mercurials in cholera, see *Calomel*).

ε. *Dropsy.*—In this disease, mercurials may do either good or harm. Thus, when the dropsical effusion depends on inflammation, they may be employed with the best effects, as when hydrocephalus arises from meningitis, or hydrothorax from pleuritis. When ascites is occasioned by an enlarged liver, which compresses the vena portæ, and thereby gives rise to effusion, mercurials are sometimes beneficial. On the contrary, when dropsy occurs in old subjects, and when it depends on, or is accompanied by, general debility, salivation is almost always hurtful. In granular degeneration of the kidney, characterised by an albuminous condition of the urine, its use is

---

[1] *Op. cit.* p. 236.
[2] *Op. cit.* p. 206.
[3] *Lond. Med. Gaz.* xxi. p. 882.

those diseases com
and also in disease
subjects, mercurial
diseased spleen the

η. In chronic
commended in para
cious. I have rep
headache, and cram
blood-letting and p
man) was kept und
Colles[1] has likewise
epilepsy, hysteria, ti
mercury has been us

The foregoing a
mercurials have been

HYDRARGYRUM P
Commerce, lbs. iij.;
introduced the Quick
hood of sheet iron i
two-thirds of the m
the acid and water, a
cantation removed th
and dried by the appl
been already stated.
and therefore the pr
unnecessary. By me
in an earthen retort, t
adapted. A wash-ha
whole of the mercury
tillation is to separat
which it may be conta

168. HYDRARGYRUM CUM CRETA.—MERCURY WITH CHALK.

HISTORY.—This compound (called, also, *mercurius alcalisatus*, or *æthiops absorbens*) is first mentioned, I believe, by Burton, in 1738.

PREPARATION.—All the British Colleges give directions for its preparation.

The *London College* directs us to take—Of Mercury, ℥iij.; Prepared Chalk, ℥v. Rub them together until globules are no longer visible. The directions of the *Edinburgh College* are similar.

The *Dublin College* orders it to be thus prepared.—Take of Pure Mercury, ℥j.; Prepared Chalk, ℥ij. Rub the mercury and chalk in a porcelain mortar, until the metallic globules cease to be visible, and the mixture acquires an uniform grey colour.

If this powder be digested in acetic acid, the lime of the chalk is dissolved, and the carbonic acid escapes; but the greater part, if not the whole, of the mercury is insoluble in the acid,—and hence it is not in the state of suboxide. If examined by a lens, the residuum is found to consist of minute separate globules, which readily whiten silver and gold, showing they are in the metallic state. Hence it is probable that the quicksilver is mechanically divided only.

PROPERTIES AND CHARACTERISTICS.—It is a greyish powder, which effervesces on the addition of acetic acid, yielding a solution of lime, which may be distinguished by the tests for the calcareous salts already mentioned. By digestion in nitric acid, we obtain a solution known to contain mercury by the characters already detailed for the mercurial preparations generally. By heat, the mercury is volatilised, leaving the chalk.

Part is evaporated by heat; what remains is colourless and corresponds in properties to prepared chalk.—*Ph. Lond.*

COMPOSITION.—It is a mechanical mixture of three parts of finely divided *mercury* and five of *chalk*.

PHYSIOLOGICAL EFFECTS.—It is an exceedingly mild but valuable mercurial. In full doses, it acts as a gentle laxative, promoting the secretion of bile and intestinal mucus, but sometimes creating a little sickness. The chalk renders it antacid. By repeated use, it occasions the constitutional effects of mercury already described.

USES.—It is a valuable remedy in *syphilis infantum*. It is frequently employed to promote and improve the secretions of the liver, pancreas, and bowels, in various disordered conditions of the digestive organs accompanied by clay-coloured stools or purging. In strumous affections of children (especially enlarged mesenteric glands), and other chronic maladies, it is administered with great advantage as an alterative.

ADMINISTRATION.—To adults, it is given in doses of from five grains to a scruple or half a drachm. It should be given in the form of powder. Pills made of it, and allowed to become hard, present internally large globules of mercury. This arises from the contraction of the substance used to form the pill mass, by which the minute globules are squeezed out and coalesce. For children, the dose is two or three grains. Rhubarb, carbonate of soda, or, in some cases, Dover's powder, may be conjoined with it.

169. HYDRARGYRUM CUM MAGNESIA.—MERCUR WITH MAGNESIA.

The Dublin Pharmacopœia gives the following directions for the preparat of this compound:—

Take of Pure Mercury, ℥j.; Carbonate of Magnesia, ℥ij. The method of preparati the same as for *hydrargyrum cum cretâ.*

The effects, uses, and doses of this preparation, are similar to those *hydrargyrum cum cretâ.*

170. PILULÆ HYDRARGYRI.—PILLS OF MERCUR

HISTORY.—The oldest formula for mercurial pills is that of Barbaross one time admiral of the Turkish fleet, and afterwards sultan of Algiers), which was communicated by him to Francis the First, king of France, made it public. The common name for this preparation is *blue pill, pilula cærulea* (*pilula hydrargyri*, L.)

PREPARATION.—The following are the directions of the British Colleges the preparation of these pills:—

The *London College* orders of Mercury, ℥ss.; Confection of Red Rose, ʒvj.; Liquc (root), powdered, ʒij. Rub the mercury with the confection until globules can no lo be seen; then, the liquorice being added, beat the whole together to form a mass.

The *Edinburgh College* orders of Mercury, two parts; Conserve of Red Roses, t parts; Liquorice Root, in powder, one part. Beat the mercury and conserve into a form mass until globules of mercury can no longer be detected; then add the liquc powder, and heat the whole again into a proper mass, which is to be divided into grain pills.

The *Dublin College* gives the following formula:—Take of Pure Mercury, ℥ij.; Con tion of Red Roses, ℥iij.; Liquorice Root, in fine powder, ℥j. Rub the mercury with confection until the metallic globules are no longer visible; then add the liquorice pow and mix the whole well together.

The friction is usually effected by steam power. By trituration, the me is reduced to a finely divided state, and becomes intimately mixed with confection and liquorice powder.

PROPERTIES.—It is a soft mass, of a convenient consistence for maki into pills, and has a dark blue colour. When rubbed on paper or glass, ought to present no globules; but applied to gold, it communicates a silv stain.

COMPOSITION.—Three grains of this pill contain one grain of mercury.

IMPURITY.—If any sulphuric acid should have been added to the confecti to brighten its colour, some subsulphate of mercury will be formed,—a co pound which possesses very energetic properties.

In a circular issued by the College of Pharmacy of New York,[1] it is stat that the following mixture was imported from a manufactory in a provinc town in England, and sold as blue pill:—*Mercury* 7·5, *earthy clay* 27 *Prussian blue*, used in colouring, 1·5, *sand*, in combination with the cl 2·0, *soluble saccharine matters* 34·0, *insoluble organic matters* 12, a *water* 16·0=100·0.

---

[1] *Pharmaceutical Journal*, vol. vii. p. 251, 1847.

PHYSIOLOGICAL EFFECTS.—In full doses (as from five to fifteen grains), it frequently acts as a purgative. In small doses it is alterative, and, by repetition, produces the before-mentioned constitutional effects of mercurials.

USES.—The practice of giving a blue pill at night, and a senna draught the following morning, has become somewhat popular, in consequence of its being recommended by the late Mr. Abernethy, in various disorders of the chylopoietic viscera. As an alterative, in doses of two or three grains, blue pill is frequently resorted to. Lastly, it is one of the best internal agents for exciting salivation in the various diseases for which mercury is adapted.

ADMINISTRATION.—The usual form of exhibiting it is in the form of pill, in the doses already mentioned; but it may also be administered when suspended in a thick mucilaginous liquid. If the object be to excite salivation, we may give five grains in the morning, and from five to ten in the evening; and, to prevent purging, opium may be conjoined.

171. UNGUENTUM HYDRARGYRI.—OINTMENT OF MERCURY.

HISTORY.—Mercurial ointment was known to, and employed by, the ancient Arabian physicians,—for example, Abenguefit, Rhazes, and Avicenna; so that it has been in use certainly 1000 years. However, Gilbertus Anglicus, who lived about the commencement of the thirteenth century, was the first who gave a detailed account of the method of extinguishing mercury by fatty matters. Besides its more common appellation of ***mercurial ointment***, it was formerly termed ***blue*** or ***neapolitan ointment***.

PREPARATION.—The following are the directions for preparing the ***unguentum hydrargyri***, L. E. D.

Take of Mercury, lb. j.; Lard, ℥xiss.; Suet, ℥ss. *L.* [Take of Mercury, lb. iij.; Lard, ℥xxiij.; Suet, ℥j. *E.*] First rub the mercury with the suet and a little of the lard until globules can no longer be seen; then add that which is left, to the lard, and mix, *L. E.*—The *Dublin College* uses equal parts of Purified Mercury and prepared Hog's Lard.—The *Edinburgh College* observes, that "This ointment is not well prepared so long as metallic globules may be seen in it with a magnifier of four powers."

To promote the extinction of the mercury, the metal should be previously triturated with some old mercurial ointment. Rancid lard also assists the extinction of the globules. The mercury in this ointment is in a finely-divided metallic state. Guibourt[1] states that, by digesting ether on mercurial ointment, the fatty matter may be dissolved, and liquid mercury obtained in equal weight to that used in making the ointment. Mr. Donovan, however, thinks that part of the mercury attracts oxygen, and that the oxide thus formed unites with the fatty matter. I have seen no satisfactory explanation of the efficacy of old mercurial ointment in extinguishing the mercury: Guibourt offers the following:—By trituration, both lard and mercury assume oppositely electrical states, the lard becoming negative, the mercury positive: these states, he supposes, determine a more intimate mixture of the particles, and a greater division of the mercury. Now rancid lard and old mercurial ointment, having attracted oxygen from the air, more readily take on the

---

[1] *Pharm. Raisonnée*, ii. 140.

169. HYDRARGYRUM CUM MAGNESIA.—MERCURY WITH MAGNESIA.

The Dublin Pharmacopœia gives the following directions for the preparati of this compound:—

Take of Pure Mercury, ℥j.; Carbonate of Magnesia, ℥ij. The method of preparatio the same as for *hydrargyrum cum cretâ*.

The effects, uses, and doses of this preparation, are similar to those *hydrargyrum cum cretâ*.

170. PILULÆ HYDRARGYRI.—PILLS OF MERCURY

HISTORY.—The oldest formula for mercurial pills is that of Barbarossa one time admiral of the Turkish fleet, and afterwards sultan of Algiers), a which was communicated by him to Francis the First, king of France, w made it public. The common name for this preparation is *blue pill*, *pilula cærulea* (*pilula hydrargyri*, L.)

PREPARATION.—The following are the directions of the British Colleges the preparation of these pills:—

The *London College* orders of Mercury, ℥ss.; Confection of Red Rose, ʒvj.; Liquo (root), powdered, ʒij. Rub the mercury with the confection until globules can no lo be seen; then, the liquorice being added, beat the whole together to form a mass.

The *Edinburgh College* orders of Mercury, two parts; Conserve of Red Roses, th parts; Liquorice Root, in powder, one part. Beat the mercury and conserve into a u form mass until globules of mercury can no longer be detected; then add the liquo powder, and heat the whole again into a proper mass, which is to be divided into grain pills.

The *Dublin College* gives the following formula:—Take of Pure Mercury, ℥ij.; Con tion of Red Roses, ℥iij.; Liquorice Root, in fine powder, ℥j. Rub the mercury with confection until the metallic globules are no longer visible; then add the liquorice pow and mix the whole well together.

The friction is usually effected by steam power. By trituration, the me is reduced to a finely divided state, and becomes intimately mixed with t confection and liquorice powder.

PROPERTIES.—It is a soft mass, of a convenient consistence for maki into pills, and has a dark blue colour. When rubbed on paper or glass, ought to present no globules; but applied to gold, it communicates a silve stain.

COMPOSITION.—Three grains of this pill contain one grain of mercury.

IMPURITY.—If any sulphuric acid should have been added to the confecti to brighten its colour, some subsulphate of mercury will be formed,—a com pound which possesses very energetic properties.

In a circular issued by the College of Pharmacy of New York,[1] it is stat that the following mixture was imported from a manufactory in a provinci town in England, and sold as blue pill:—*Mercury* 7·5, *earthy clay* 27· *Prussian blue*, used in colouring, 1·5, *sand*, in combination with the cla 2·0, *soluble saccharine matters* 34·0, *insoluble organic matters* 12, an *water* 16·0=100·0.

---

[1] *Pharmaceutical Journal*, vol. vii. p. 251, 1847.

PHYSIOLOGICAL EFFECTS.—In full doses (as from five to fifteen grains), it frequently acts as a purgative. In small doses it is alterative, and, by repetition, produces the before-mentioned constitutional effects of mercurials.

USES.—The practice of giving a blue pill at night, and a senna draught the following morning, has become somewhat popular, in consequence of its being recommended by the late Mr. Abernethy, in various disorders of the chylopoietic viscera. As an alterative, in doses of two or three grains, blue pill is frequently resorted to. Lastly, it is one of the best internal agents for exciting salivation in the various diseases for which mercury is adapted.

ADMINISTRATION.—The usual form of exhibiting it is in the form of pill, in the doses already mentioned; but it may also be administered when suspended in a thick mucilaginous liquid. If the object be to excite salivation, we may give five grains in the morning, and from five to ten in the evening; and, to prevent purging, opium may be conjoined.

171. UNGUENTUM HYDRARGYRI.—OINTMENT OF MERCURY.

HISTORY.—Mercurial ointment was known to, and employed by, the ancient Arabian physicians,—for example, Abenguefit, Rhazes, and Avicenna; so that it has been in use certainly 1000 years. However, Gilbertus Anglicus, who lived about the commencement of the thirteenth century, was the first who gave a detailed account of the method of extinguishing mercury by fatty matters. Besides its more common appellation of *mercurial ointment*, it was formerly termed *blue* or *neapolitan ointment*.

PREPARATION.—The following are the directions for preparing the *unguentum hydrargyri*, L. E. D.

Take of Mercury, lb. j.; Lard, ℥xiss.; Suet, ℥ss. *L.* [Take of Mercury, lb. iij.; Lard, ℥xxiij.; Suet, ℥j. *E.*] First rub the mercury with the suet and a little of the lard until globules can no longer be seen; then add that which is left, to the lard, and mix, *L. E.*—The *Dublin College* uses equal parts of Purified Mercury and prepared Hog's Lard.—The *Edinburgh College* observes, that "This ointment is not well prepared so long as metallic globules may be seen in it with a magnifier of four powers."

To promote the extinction of the mercury, the metal should be previously triturated with some old mercurial ointment. Rancid lard also assists the extinction of the globules. The mercury in this ointment is in a finely-divided metallic state. Guibourt[1] states that, by digesting ether on mercurial ointment, the fatty matter may be dissolved, and liquid mercury obtained in equal weight to that used in making the ointment. Mr. Donovan, however, thinks that part of the mercury attracts oxygen, and that the oxide thus formed unites with the fatty matter. I have seen no satisfactory explanation of the efficacy of old mercurial ointment in extinguishing the mercury: Guibourt offers the following:—By trituration, both lard and mercury assume oppositely electrical states, the lard becoming negative, the mercury positive: these states, he supposes, determine a more intimate mixture of the particles, and a greater division of the mercury. Now rancid lard and old mercurial ointment, having attracted oxygen from the air, more readily take on the

---

[1] *Pharm. Raisonnée*, ii. 140.

negative condition, a
mercurial globules.
better adapted for n
their power of conduc

Properties.—It i
properly prepared, gi
examined by a magnif
it. When examined
observed. In well-m
by the naked eye, bei
found the sp. gr. of
at 60° F. Two othe
respectively a sp. gr.
kept in a moderatel
exposed to great cold,
lisation, I presume, of

Composition.—Th
and finely divided *me*

Strength and Pu
a smaller proportion o
copœias; and, in orde
tersulphuret of antimo

In order to ascertai
to obtain a standard
purpose the ointment

The qualities which
sample, are its colour,
well as under a powerf
the globules, their nun
should then be observe
from the mercury, and
means of ether or tu
C. Watt[2] gives the foll
with boiling water, and
the surface, pour off th
tion of soap [or caustic

Physiological Eff
of irritating the parts
rubbed into the integu
mercury. Thus Culler
grains of this ointmen
violent salivation. He
in a very short space of
ointment in the space o
capable of producing th
and if the lard which it
usually produced. Ap

---

[1] Eh
[2] *The*

stimulant, and in syphilitic sores is oftentimes a very useful and beneficial application. [Dr. F. von Bœrensprung[1] has performed some experiments on dead and living animal membranes, to ascertain in what manner mercury enters the system when rubbed on externally in the form of ointment; and he has come to the conclusion, that the metallic mercury, as such, does not pass into the body. By analytical examination, it was found that mercurial ointment consists of peroxide of mercury, metallic mercury, and fatty matter, as asserted by Donovan and Christison, although doubted by Mitscherlich. This oxide, it is suggested by Dr. Bœrensprung, is dissolved by the free acid of the cutaneous secretion. The uncertain action of mercurial ointment is explained by the varying proportions of peroxide of the metal. In order, therefore, to obtain uniform effects, an ointment containing the peroxide should be used. Mercurial vapour, according to the same author's experiments on rabbits, proves injurious by becoming condensed and oxidised in the lungs, where absorption and symptoms of mercurialism commence.—ED.]

USES.—It is rarely or never administered *internally* in this country, but has been much used on the continent, and with great success. Cullerier says, the difficulty with him has been rather to check than to excite salivation by it.

Applied *externally*, it is employed either as a local or constitutional remedy. Thus, as a *local* agent, it is used as a dressing to syphilitic sores, and is rubbed into tumours of various kinds (not those of a malignant nature, as cancer and fungus hæmatodes), with the view of causing their resolution. Sometimes, also, it is employed to destroy parasitic animals on the skin. As a *means of affecting the constitution*, we use mercurial inunctions in syphilis, in inflammatory diseases, and, in fact, in all the cases (already noticed) in which our object is to set up the mercurial action in the system, more especially when the irritable condition of the digestive organs offers an objection to the internal employment of mercurials. It may be laid down as a general rule, that mercury may be used with more safety by the skin than by the stomach; but reasons of convenience, which I have already alluded to, frequently lead us to prefer its internal use.

ADMINISTRATION.—*Internally*, it is given in doses of from two to five grains, made into pills, with either soap or some mild powder, as liquorice. *Externally*, when the object is to excite very speedy salivation, half a drachm may be rubbed into the skin every hour, washing the part each time, and varying the seat of application. If, however, it be not desirable or necessary to produce such speedy effect, half a drachm, or a drachm, rubbed in night and morning, will be sufficient. During the whole course of inunction, the patient should wear the same drawers night and day.

When the friction is performed by a second person, the hand should be enveloped with soft oiled pig's bladder, turned inside out.[2] Mercurial frictions ought not to be violent, but long continued, and had better be carried on near a fire, in order to promote the liquefaction and absorption of the ointment. In syphilis, and other diseases in which our sole object is the constitutional affection, it matters little to what part of the body the ointment is applied, provided the cuticle be thin (for this layer offers an impediment to absorption in proportion to its thickness). The internal parts

---

[1] *Pharmaceutical Journal*, 1850–51, p. 554.

[2] Colles, *op. cit.* p. 42.

of the thighs are usu
the inunctions are ma
use of the warm bath
the skin.

1. **CERATUM HY**
Mercury. (Take of
phor, ℥iss. Rub the
enlarged joints and in
the Pharmacopœia on

2. **LINIMENTUM H**
(Stronger Ointment c
Spirit, f℥j.; Solution
spirit, then with the
ammonia being grad
friction) in chronic t
the object is to ex
readily than the co
ammonia.

172. EMPLAS

Both the London a
of this plaster.

The *London College* or
Sulphur, grs. viij. To th
spatula until they incorpo
no longer visible; then g
mix them all.

In this process the
mercury. The remain

The *Edinburgh College*
Plaster, ℥vj. Liquefy tog
triturate till its globules
liquefied; and mix the w
The *Dublin College* give
℥ij.; Oil of Turpentine, f
with the aid of heat, add
to be visible, and the mix
previously melted, and sti

It is supposed to sti
is applied, and is used
swellings, whether ven
in hepatic complaints.

---

[1] *Surgical Observations on*
cularly as exemplified in Dis
[2] *Op. cit.*

EMPLASTRUM AMMONIACI CUM HYDRARGYRO, L. D.; *Emplastrum Ammoniaci et Hydrargyri*, E.; *Plaster of Ammoniacum with Mercury*. (Ammoniacum, lb. j.; Mercury, ℥iij.; Olive Oil, f℥j.; Sulphur, grs. viij. To the heated oil gradually add the sulphur, stirring constantly with a spatula until they incorporate; then rub the mercury with them until globules are no longer visible; lastly, gradually add the ammoniacum, melted, and mix them all. *L. E.*—The *Dublin College* orders of Ammoniac Plaster, ℥iv.; Mercurial Plaster, ℥viij. Melt them together by means of a steam or water-bath, and stir constantly until the mixture stiffens on cooling.)—This compound, like the preceding, is employed especially to disperse venereal buboes. It frequently excites an eczematous eruption.

173. HYDRARGYRI SUBOXYDUM.—SUBOXIDE OF MERCURY.

Formula Hg^2O. *Equivalent Weight* 208.

HISTORY.—The mode of preparing this compound was taught by Moscat, in 1797. This oxide is sometimes termed the *protoxide, oxide, dioxide, ash, grey*, or *black oxide* (*hydrargyri oxydum*, vel *hydrargyri oxydum cinereum*, seu *hydrargyri oxidum nigrum*).

PREPARATION.—This compound is not met with in any of the British Pharmacopœias. It may be prepared in decomposing calomel by lime water, or by solution of potash.

In both processes double decomposition takes place: 1, chloride of calcium is formed in solution, while suboxide of mercury precipitates ($Hg^2Cl+CaO=Hg^2O+CaCl$); and 2, as potash is used instead of lime, the products are chloride of potassium in solution, and suboxide of mercury precipitated ($Hg^2Cl+KO=Hg^2O,KCl$).

PROPERTIES.—Pure suboxide of mercury is black, or nearly so. The present preparation, however, is frequently greyish, owing to the presence of some undecomposed calomel. It is readily decomposed by light (especially by the solar rays), becomes olive-coloured, and is resolved into metallic mercury and the red oxide. It is odourless, tasteless, insoluble in water and alkalies, but is soluble in nitric and acetic acids. By the action of hydrochloric acid it forms water and calomel. When heated, it is first decomposed, and then completely dissipated.

Characteristics.—Heated in a glass tube it evolves oxygen, while metallic globules are sublimed. Dissolved in diluted nitric acid it forms a protomercurial salt, known by the before-mentioned characters for these substances.

COMPOSITION.—The composition of this oxide is as follows:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Sefström.*	*Thénard.*
Mercury	2	200	96·15	96·2	96·16
Oxygen	1	8	3·85	3·8	3·84
Suboxide of Mercury	1	208	100·00	100·0	100·00

PURITY.—Digested for a short time in dilute hydrochloric acid, the solution, when filtered, should form no precipitate with either potash or oxalate of ammonia. If any red oxide had been dissolved, the potash would throw it down as a reddish or yellowish hydrate. If any carbonate of lime had been present, the oxalate would detect the presence of lin solution.

PHYSIOLOGICAL EFFECTS.—Pure suboxide of mercury is one of irritating of the mercurial preparations, and, therefore, when swallow not produce much disorder of the alimentary canal. In small doses an alterative and purgative. When taken in repeated doses, its cons effects are similar to those of other mercurials.

USES.—Mr. Abernethy employed it as a fumigating agent. The are his directions for using it:—Place the patient in a vapour b complete suit of under garments, with a cloth round his chin. Two of the oxide are then to be put on a heated iron within the machine the patient is sitting. After continuing in the bath for about fifteen minutes, the body is found to be covered with a whitish powder. Th should be placed in bed, and lie in the same clothes till morning, go into a tepid bath. By this mode of proceeding Mr. Abernethy has known salivation induced in forty-eight hours.

Suboxide of mercury is rarely employed as an internal remedy; in varying composition is a strong objection to its use. As an extern cation it has been used in the form of *ointment* (composed of one oxide and three parts of lard), and also suspended in a weak sol chloride of calcium, under the name of *black wash*.

ADMINISTRATION.—For internal use, the dose is from half a grain or three grains.

LOTIO NIGRA; *Black Wash; Aqua Mercurialis Nigra; Aqu gedænica mitis.*—This is prepared by adding calomel to lime-wate proportions of the ingredients may be varied, but in general, one dr calomel is used to a pint of lime-water. Suboxide of mercury is precipita chloride of calcium remains in solution. As the efficacy of the wash on the suboxide, the bottle must be well shaken each time that it is use compound is a favourite application to venereal sores of almost all kin most being serviceable, in few or none being hurtful.

174. HYDRARGYRI OXYDUM RUBRUM.—RED O OF MERCURY.

Formula HgO. *Equivalent Weight* 108.

HISTORY.—This is the *peroxide* or *binoxide of mercury* of some Geber[1] describes the method of making that variety of it which is p by calcination, and which was formerly called *red precipitate per se curius præcipitatus ruber per se*), or *calcined mercury* (*hydrar calcinatum*). He calls it *coagulated mercury*.

PREPARATION.—This compound may be prepared either by precipita by calcination.

The *London College* gives no formula for its preparation.

The *Dublin College*, under the name of *Hydrargyri Oxydum Rubrum*, gives a which produces the compound usually known as *Hydrargyri Nitrico-Oxydum*. be presently described.

---

[1] *Sum of Perfection*, book i. part iv. ch. 16.

The old process consisted in keeping mercury heated to 600° in a convenient vessel for a considerable time.

The heat vapourised the mercury, which in this state attracted oxygen from the air, and formed this red or peroxide. The long neck of the vessel prevented the escape of the vapours of the newly-formed oxide.

The process was a very tedious one, occupying several weeks: so that Geber's remark was correct, that "it is a most difficult and laborious work, even with the profoundness of clear-sighted industry." The apparatus which Mr. Boyle contrived for the manufacture of it, was long termed "*Boyle's Hell*," from a notion that the mercury was tortured in it.

PROPERTIES.—When prepared by precipitation, it is in the form of an orange-red powder: but when made by calcination, it occurs in small brilliant scales of a ruby-red colour. Both varieties agree in the following properties: they are odourless, have an acrid metallic taste, are very slightly soluble in water,[1] but readily soluble in both nitric and hydrochloric acids. They are decomposed and reduced by heat and solar light; the precipitated variety is more readily acted upon by solar light than the variety made by calcination.

Characteristics.—When heated in a glass tube by a spirit lamp, it is decomposed into oxygen and mercury: the first may be recognised by a glowing match, the second condenses in small globules. It dissolves completely in hydrochloric acid: the solution contains corrosive sublimate, which may be known by the tests hereafter to be mentioned for this substance.

COMPOSITION.—The composition of this substance is as follows:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Sefström.*	*Donovan.*
Mercury	1	100	92·59	92·68	92·75
Oxygen	1	8	7·41	7·32	7·25
Red Oxide of Mercury	1	108	100·00	100·00	100·00

Red oxide of mercury prepared by precipitation usually contains some water.

PURITY.—Red oxide of mercury should be completely dissipated by heat, and be insoluble in water. Its solution in nitric acid should be unaffected by nitrate of silver, by which the absence of any chloride is shown. If an insufficient quantity of potash be employed in the preparation of the precipitated variety, the product is brownish or brick-dust coloured, and contains oxichloride of mercury (composed, according to Soubeiran,[2] of $HgCl,3HgO$).

PHYSIOLOGICAL EFFECTS.—Red oxide of mercury is a powerful irritant, and, when taken internally, even in small doses, readily excites vomiting and purging: large doses excite gastro-enteritis. Orfila[3] found that the red oxide, obtained by precipitation from four grains of corrosive sublimate, killed a dog in eighteen minutes. The constitutional effects of this preparation are the same as those of mercurials generally.

USES.—Red oxide of mercury is rarely employed as a medicine. It has been applied as an escharotic, either in the form of powder or ointment. Internally it was formerly exhibited to excite salivation in venereal diseases, but is objectionable, especially where the bowels are morbidly irritable. It is rarely or never used now.

In pharmacy, it is employed in the preparation of cyanide of mercury.

---

[1] *Journ. de Pharm.* t. xxiv. p. 252.
[2] Dumas, *Traité de Chimie*, iii. 615.
[3] *Toxicol. Gén.*

ADMINISTRATION.—
given in the form of

LOTIO FLAVA; *Lo*
Wash.—This compou
adding corrosive subl
formulæ. The quant
to an ounce of lime-
ounces of lime-water.
oxide of mercury (whi
the two latter being i
exceed $3\frac{7}{10}$ grains t
brickdust coloured,
liquor holds in soluti
combination, in which
the acid.[1] Yellow or
and scrofulous ulcers.
which succeed to bur
state.

175. HYDRA

HISTORY.—This pr
part of the thirteent
mercury (*mercurius*
PREPARATION.—All
of it.

The *London College* ord
Oij. Mix, and apply a ge
and rub the residue into
apply a slow fire, and gra
The *Edinburgh College* d
Dissolve half of the merc
the heat till a dry salt is
fine uniform powder be ob
stir it till acid fumes ceas
The *Dublin College* ord
Water, ℥vj. In the acid,
gentle heat, but, when th
decanted the solution, eva
be transferred to a shallow
tile lid; and in this let it
be given off. The heat m
tents should be transferre
[The Dublin College no
it as the Hydrargyri Oxyd
which is procured directly
contact with air or oxygen

---

[1] Guibourt, *Journ. Chim.*
Traité de Pharm. ii. 529.
[2] *Brit. and For. Med. Rev.*

This compound is best prepared on a large scale, for it cannot be so well procured of the bright orange-red colour and crystalline or scaly appearance usually considered desirable, when only small quantities of materials are employed. The reduction of the nitrate to powder is objectionable, as it diminishes the crystalline appearance of the oxide. Mr. Brande[1] says "the nitrate requires to be constantly stirred during the process, which is usually performed in a cast iron pot." But in general a shallow earthen dish is employed, with a second one inverted over it, and care is taken not to disturb the nitrate during the operation. The heat of the sand-bath is employed. Indeed, some have asserted that the finest product is obtained when the calcination is performed in the same vessel in which the nitrate was formed, and without stirring.[2]

When quicksilver and the diluted nitric acid are digested together, the metal is oxidised at the expense of part of the acid, while binoxide of nitrogen escapes, and, combining with the oxygen of the air, becomes nitrous acid. The oxidised metal unites to some undecomposed nitric acid to form a nitrate of the suboxide. $6Hg+4NO^5=NO^2+3(Hg^2O,NO^5)$. When this nitrate is heated, decomposition takes place: the nitric acid yields oxygen to the suboxide of mercury, which thereby becomes red oxide of mercury, while nitrous acid (or its elements) escapes. $Hg^2O,NO^5=2HgO+NO^4$. Some pernitrate of mercury usually remains undecomposed, but the quantity is small. Mr. Brande states, that 100 pounds of mercury and 48 pounds of nitric acid (sp. gr. 1·48) yielded 112 pounds of nitric oxide of mercury. Hence three pounds of nitric acid must have remained in combination with the oxide.

PROPERTIES.—It occurs in bright tile-red, or scarlet, crystalline grains or scales. Dr. Barker[3] found that 1000 parts of water took up 0·62 of this oxide. The other properties and characteristics of this compound are the same as those of the last-mentioned preparation (see *hydrargyri oxydum rubrum*).

PURITY.—The presence of some undecomposed nitrate may be recognised by heating the suspected nitric oxide of mercury, when nitrous vapours are evolved, and by boiling in water, when a solution is obtained, from which lime water and hydrosulphuric acid throw down precipitates. The nitric oxide of mercury is completely dissipated by heat: hence the presence of non-volatile matters (as red lead) might be readily detected. Heated before the blow-pipe on charcoal, the mercurial oxide is reduced and dissipated, but if red lead be present, globules of metallic lead will be left behind.

It consists of shining red crystalline scales. Heated to full redness it evolves no nitric vapours. It is soluble in hydrochloric and in nitric acid.—*Ph. Lond.*

Entirely soluble in muriatic acid: heat decomposes it and sublimes it entirely in metallic globules, without any discharge of nitrous fumes.—*Ph. Ed.*

PHYSIOLOGICAL EFFECTS.—Its local action is that of a powerful irritant (vide *hydrargyri oxydum rubrum*). But the presence of nitrate of mercury in the nitric oxide renders its topical action more energetic. Its constitutional effects are the same as those of other mercurials.

Fabricius Hildanus, Bartholinus, Langius, and Jacobs,[4] have reported cases in which the external use of this agent gave rise to salivation and constitutional effects of mercury. In the case mentioned by Jacobs, resulted from the application of it to a wart on the face. Frederic Hoff Ploucquet, Girtanner,[1] and Dr. Brett,[2] have related instances of poisonin its internal employment.

---

[1] *Manual of Chemistry.*

[2] Dr. Barker, *Observ. on the Dublin Pharmacopœia.*

[3] *Op. cit.*

[4] Quoted by Wibmer, *Wirkung d. Arzneim.* iii. 69.

USES.—Internally, it has been administered in the form of pill in ven diseases, but the practice is highly objectionable.

As an external agent, it is used in the form of powder (obtained by gation) or ointment; the latter is officinal. As a caustic, it is sprin over spongy excrescences, venereal warts, chancres, and indolent fun ulcers. Mixed with eight parts of finely-powdered white sugar, it ma blown into the eye with a quill in opacity of the cornea.[3]

UNGUENTUM HYDRARGYRI NITRICO-OXYDI, L.; *Unguentum Oxidi drargyri*, E.; *Unguentum Hydrargyri Oxydi Rubri*, D. (Finely- dered Nitric Oxide of Mercury, ℥j.; White Wax, ℥ij.; Lard, ℥vj. *L.* The *Edinburgh College* employs Nitric Oxide of Mercury, ℥j.; I ℥viij. The *Dublin College*—Red Oxide of Mercury, ʒj.; Ointmen White Wax, ʒvij. Reduce the oxide to a very fine powder and mix it mately with the ointment by trituration, *D.*)—This ointment undergoes composition by keeping—its colour changing from red to grey, in consequ of the partial deoxidation of the nitric oxide of mercury. Dr. Duncan[4] the presence of resin quickly causes it to become black. It is a valuable mulant, and is frequently applied to indolent sores and ulcers when we re to increase the quantity and improve the quality of the discharge; to infla eyelids (*ophthalmia tarsi*), and chronic conjunctivitis.

176. HYDRARGYRI SULPHURETUM.—SULPHURET MERCURY.

Formula HgS. *Equivalent Weight* 116.

Two forms of this compound are used in medicine, one crystallised or the other amorphous or black.

1. Hydrargyri Sulphuretum Crystallisatum vel Rubrum.— Crystallised or Red Sulphuret of Mercury.

HISTORY.—Crystallised or red sulphuret of mercury was known in most ancient times. *Vermilion* is mentioned twice in the Old Testamen Theophrastus[6] states that there are two kinds of cinnabar (*κιννάβαρι, cin baris*), one native, the other factitious: the first was sulphuret of mercu the second, he says, was a scarlet sand.

---

[1] Wibmer, *op. cit.*

[2] *Lond. Med. Gaz.* xiii. 117. A case of poisoning with it is also recorded in the *Lancet* 1836–37, vol. i. p. 401.

[3] Mackenzie, *On Diseases of the Eye*, 2d edit. p. 584.

[4] *Edinb. Dispensatory.*

[5] *Jeremiah*, xxii. 14; *Ezekiel*, xxiii. 14.

[6] *De Lapidibus*, p. 399, ed. Heins. 1613; Hill's translation, 2d edit. p. 227. 1774.

Geiger[1] found it in the colouring matter of the old Egyptian tombs. It was formerly called *minium*.[2] It is sometimes termed *bisulphuret of mercury* (*hydrargyri bisulphuretum*, Ph. L.)

NATURAL HISTORY.—The principal repositories of *native cinnabar* (*cinnabaris nativa*) are Idria in Carniola, and Almaden in Spain. It occurs both massive and crystallised; the primary form of its crystals being the acute rhombohedron.

PREPARATION.—Two of the British Colleges give directions for the preparation of this compound.

The *London College* orders of Mercury, lb. ij.; Sulphur, ℥v. Melt the sulphur, add the mercury, and continue the heat until the mixture begins to swell up. Then remove the vessel, and cover it closely to prevent the mixture taking fire. When the material is cold, reduce it [the mass] to powder, and sublime it.

The process of the *Edinburgh College* is similar.

The *Dublin College* gives no process.

In this process the heat enables the mercury and sulphur to combine and form black or amorphous sulphuret of mercury. When large quantities of sulphur and mercury are heated together, a slight explosion and flame are produced. By sublimation, the black sulphuret is converted into *cinnabar*, or the red or crystallised sulphuret.[3]

PROPERTIES.—Artificial cinnabar has, in the mass, a dark reddish-brown crystalline appearance; but, when reduced to a fine powder, is of a beautiful scarlet-red colour, and is then termed *vermilion*. It is tasteless, odourless, insoluble in water or alcohol, and unalterable in the air. It is fusible and volatile. It burns in the air with a blue flame, the sulphur uniting with oxygen to form sulphurous acid, while the mercury is dissipated in a vaporous form.

Characteristics.—Heated in a glass tube, with carbonate of soda, it evolves mercurial vapour, which condenses into liquid globules of this metal. The residue, which is sulphuret of sodium, gives out hydrosulphuric acid on the addition of hydrochloric acid. The colour of cinnabar deepens under the influence of heat.

COMPOSITION.—Its composition is as follows:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Guibourt.*	*Sefström.*	*Erdmann and Marchand.*
Mercury	1	100	86·21	86·21	86·29	86·211
Sulphur	1	16	13·79	13·79	13·71	13·789
Sulphuret of Mercury	1	116	100·00	100·00	100·00	100·004

PURITY.—Pure cinnabar is totally volatilised by heat, and is insoluble in nitric or hydrochloric acid. If minium, or red lead, be intermixed, we may recognise it by boiling in acetic acid, by which acetate of lead is procured in solution: this forms a black precipitate with hydrosulphuric acid, white with the sulphates, and yellow with iodide of potassium. Realgar, or sulphuret of arsenicum, may be detected by boiling the suspected cinnabar in solution of caustic potash, supersaturating with nitric acid, and passing a current of

---

[1] *Handb. d. Pharm.* by Liebig.

[2] Pliny, *Hist. Nat.* lib. xxxiii. cap. 38, ed. Valp.

[3] Full details respecting the Dutch method of manufacturing cinnabar are given in the *Ann. de Chim.* iv. 25; and in Aikin's *Dict. of Chemistry*, vol. ii. p. 87.

hydrosulphuric acid through it, by which a yellow precipitate
obtained. Earthy impurities are not volatile.

Totally evaporated by heat; and on potash being added to it, runs into
mercury.—*Ph. Lond.*

"It is sublimed entirely by heat, and without any metallic globules being
Ph. Ed.

Physiological Effects.—According to Orfila[1] pure cinnabar
for he found no effects were produced on dogs by half an ounce w
applied to wounds or taken into the stomach. These results bein
to those obtained by Smith[2] it has been presumed that the latter
employed an impure sulphuret.

The vapour obtained by heating cinnabar in the air is poisonou
is not in opposition to Orfila's experiments, since this vapour is not
of mercury, but a mixture of the vapour of mercury (either in the
oxidised state) and of sulphurous acid gas. Schenkius[3] has relate
of a young man who died from the use of this vapour, and Hill[4] s
violent salivation and diarrhœa, produced by its inhalation.

Uses.—Cinnabar is used merely as a fumigating agent in vene
rations of the nose and throat. The method of using it is this :—
a drachm is placed on a heated iron, and the fumes inhaled as
In the shops, a copper apparatus, with iron heater, is sold for th
In the absence of this, the sulphuret is to be placed on a hot ir
and the vapour inhaled by the patient through a funnel. The
nature of the sulphurous vapour usually excites coughing, and is in
persons disposed to phthisis. Hence the oxide of mercury is to be
for fumigation.

Administration.—When employed internally, cinnabar has bee
doses of from ten grains to half a drachm. For the purpose of fu
half a drachm may be employed.

2. Hydrargyri Sulphuretum Nigrum vel Amorphum.—Am or Black Sulphuret of Mercury.

History.—Amorphous sulphuret of mercury with excess of
(*hydrargyri sulphuretum cum sulphure*) is commonly called
mineral (*æthiops mineralis*), and is usually known in the shops as
sulphuret of mercury (*hydrargyri sulphuretum nigrum*).

It is stated that the Chinese used it long before it was known to E
Harris, in 1689, first taught the method of preparing it by triturati

Preparation.—The British Colleges give no directions for the pr
of this compound. It is no longer an article of the Materia Medica

Properties.—It is a heavy, black, tasteless, odourless powder,
in water. When heated, it fuses, and is completely dissipated.

---

[1] *Archiv. Gén. de Méd.* xix. 330.

[2] Christison, *Treat. on Poisons*, 3d edit. 395.

[3] *Observ.* L. vii.

[4] *Edinb. Med. Essays*, iv.

[5] [Instead of rubbing the sulphur and mercury together in a mortar, it has been lat
mended to prepare this compound by shaking the materials together in a bottle (*Phar*
Journal for 1849, p. 492).—Ed.]

Characteristics.—By boiling in caustic potash liquor, we obtain a solution of sulphuret of potassium. The residue is black, but possesses all the before-mentioned chemical characteristics of cinnabar.

COMPOSITION.—If this compound be, as Mr. Brande[1] supposes, a mixture of sulphuret of mercury and sulphur, the proportions must be—

	Per Cent.
Sulphuret of mercury	58
Sulphur	42
Hydrargyri Sulphuretum cum Sulphure	100

PURITY.—Free mercury may be detected by its communicating a white stain to gold. Charcoal may be detected by its not volatilising by heat. Animal charcoal, by this character, as well as by the presence of phosphate of lime in the residue. Tersulphuret of antimony may be recognised by boiling in hydrochloric acid, and applying the before-mentioned tests for terchloride of antimony.

PHYSIOLOGICAL EFFECTS.—According to the experiments of Orfila, this preparation, like the last, possesses, little or no activity. The late Dr. Duncan[2] also tells us that he has given it in doses of several drachms for a considerable length of time with scarcely any effect. It is commonly regarded as alterative.

USES.—It has been used in glandular diseases, especially of children, and also in cutaneous diseases.

ADMINISTRATION.—The dose for adults is from 5 to 30 grains.

177. HYDRARGYRI SULPHATES.—SULPHATES OF MERCURY.

There are probably four compounds of sulphuric acid with the oxides of mercury.

Sulphate of the Suboxide of Mercury	Hg^2O,SO^3
Tribasic Sulphate of the Oxide of Mercury	$3HgO, + SO^3$
Sulphate of the Oxide of Mercury	HgO,SO^3
Supersulphate of the Oxide of Mercury	$HgO,2SO^3$ (?)

Of these, two only will require separate notice here—namely, the second and third.

1. Hydrargyri Subsulphas Flavus.—Yellow Subsulphate of Mercury.

Formula $3HgO,SO^3$. *Equivalent Weight* 364.

HISTORY.—This compound was known to Croll in the sixteenth century. It has been termed *turpeth* (or *turbith*) *mineral* (*turpethum minerale*), from its resemblance in colour or action to the root of the *Ipomæa Turpethum*. It has been known by various other names; as the *tribasic sulphate of the oxide* (or peroxide) *of mercury*, the *subpersulphate of mercury*, or the *hydrargyri oxydum sulphuricum*.

---

[1] *Manual of Pharmacy*, 3d edit. 329.

[2] *Edinburgh Dispensatory*.

By the action of warm water on the persulphate of mercury there a tained a soluble supersulphate and difficultly-soluble subsulphate of mer

PROPERTIES.—It is a heavy, lemon-yellow, inodorous powder, havi acrid taste. It requires 2000 parts of water at 60°, or 600 parts at 21 dissolve it.

Characteristics.—When heated in a tube, sulphurous acid is evolve globules of mercury sublimed. Boiled with caustic potash or soda, th or peroxide of mercury is precipitated, and a solution of sulphate of p is obtained, known to be a sulphate by chloride of barium.

COMPOSITION.—Its composition is as follows:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Kane.*	*Ge*
Oxide (or Peroxide) of Mercury	3	324	89·01	88·90	8
Sulphuric Acid	1	40	10·99	10·95	1
Yellow Subsulphate of Mercury	1	364	100·00	99·85	9

PHYSIOLOGICAL EFFECTS.—In small quantities it occasions nausea, vom and ptyalism. Taken into the nostrils, it excites sneezing, and some salivation. Stenzel[1] mentions a fatal case from its internal use.

USES.—It is sometimes used as an emetic, in cases of swelled te to promote absorption by its nauseating and emetic action.[2] It was for given at the commencement of a mercurial course. As an errhine, it has administered in chronic ophthalmia and affections of the brain—as inc hydrocephalus. As an alterative, it has been given in the scaly diseases and psoriasis).

ADMINISTRATION.—As an alterative, the dose should not exceed grain, or at most a grain. As an emetic, it is given to the extent o grains, in which dose it causes violent vomiting. As an errhine, a should be mixed with four or five of some mild powder, as starch or liq powder. It is rarely given for any other purposes.

2. Hydrargyri Persulphas.—Persulphate of Mercury.

Formula HgO,SO^3. *Equivalent Weight* 148.

Sulphate of the Peroxide of Mercury; Bipersulphate of Mercury; Hydrargyri Sulph —This preparation is not used in medicine either as an internal or external remedy; pharmacy it serves for the preparation of several other mercurial compounds; as ca corrosive sublimate, and subsulphate of mercury.

The *Dublin College* gives the following formula for its preparation:—Take of Quick of commerce, ℥x.; Sulphuric Acid, f℥vj. Place the quicksilver and oil of vitrio porcelain capsule, and apply heat until effervescence ceases, and nothing remains but a and dry salt.

The *London* and *Edinburgh Colleges* give directions for the preparation of this comp in the processes for the manufacture of calomel and corrosive sublimate.

This salt is an opaque, white solid. It becomes orange-coloured at a dull red hea white on cooling: at a full red heat it is decomposed. It is decomposed by water, resolves it into a basic salt (turpeth mineral) and a supersalt.

---

[1] Wibmer, *Wirk. d. Arzneim.* iii. 66.

[2] Barker, *Observ. on the Dublin Pharmacopœia.*

178. HYDRARGYRI SUBCHLORIDUM.—SUBCHLORIDE OF MERCURY OR CALOMEL.

Formula Hg^2,Cl. *Equivalent Weight* 235·5.

HISTORY.—Beguin in 1608, and Oswald Croll in 1609, are the first Europeans who mention this compound. Mr. Hatchett[1] says it had been long known to the natives of Thibet. Its discoverer is unknown. It has had a great variety of names. The term *calomel* (*calomelas*, from καλὸς, *good*, and μέλας, *black*) was first used by Sir Theodore Turquet de Mayenne[2] (who died in 1655), in consequence, as some say, of his having had a favourite black servant who prepared it; or, according to others, because it was a *good* remedy for the *black* bile. *Drago mitigatus*, *aquila alba*, *manna metallorum*, and *panchymagogum minerale*, are some of the appellations for it. *Mercurius dulcis*, *hydrargyrum muriaticum mite*, *submuriate of mercury*, and *chloride*, *subchloride*, or *protochloride of mercury*, are some of the more modern synonymes of it.

One of the inconveniences attending the alteration of the atomic weight is, that the name (*chloride of mercury*), formerly applied to calomel, is now transferred to corrosive sublimate. This is one of the evils necessarily attendant on the adoption of scientific language in pharmacy.

NATURAL HISTORY.—*Native calomel*, or *corneous mercury*, occurs in crusts, and also crystallised in four-sided prisms terminated by pyramids. It is found at Deux-Ponts, Carniola, and in Spain.

PREPARATION.—All the British Colleges give directions for the preparation of this salt (*Hydrargyri Chloridum*, L.; *Calomelas*, D.)

The *London College* orders of Mercury, lb. iv.; Sulphuric Acid, ℥xxiss.; Chloride of Sodium, lb. iss.; Distilled Water, as much as may be sufficient. Boil two pounds of the mercury with the sulphuric acid in a proper vessel, until the bipersulphate of mercury remains dry; rub this when it is cold with (the remaining) two pounds of mercury in an earthen mortar, that they may be perfectly mixed. Afterwards add the chloride of sodium, and rub them together until globules are no longer visible; then sublime. Rub the sublimate to very fine powder, and wash it carefully with boiling distilled water, and dry it.

The *Edinburgh College* directs of Mercury, ℥viij.; Sulphuric Acid (commercial), f℥ij. and fʒiij.; Pure Nitric Acid, f℥ss.; Muriate of Soda, ℥iij. Mix the acids, add four ounces of the mercury, and dissolve it with the aid of a moderate heat. Raise the heat so as to obtain a dry salt. Triturate this with the muriate of soda and the rest of the mercury till the globules entirely disappear. Heat the mixture by means of a sand-bath in a proper subliming apparatus. Reduce the sublimate to fine powder; wash the powder with boiling distilled water until the water ceases to precipitate with solution of iodide of potassium; and then dry it.

The *Dublin College* gives the following formula:—Take of Sulphate of Mercury, lb. x.; Mercury of commerce, lb. vij.; Dried Chloride of Sodium, lb. v. Incorporate as completely as possible the sulphate and the metallic mercury by prolonged trituration, and, having then added the chloride of sodium, previously reduced to a fine powder, rub all well together until a perfectly equable mixture is obtained. Heat this through the medium of sand, in a shallow iron pot with a flat bottom, lined with clay, and covered with a lid of cast iron, until the sublimate, which attaches itself to a circular plug in the centre of the lid (which admits of being removed and cleaned from time to time), neither exhibits minute globules of mercury, nor is rendered yellow by being touched with a solution of

---

[1] Brande's *Manual of Pharmacy*, 2d edit. 328.

[2] *Annals of Philosophy*, vol. ii. N. S. p. 427. See also the old series of this journal, vol. xvi. pp. 309, 394, and 426.

one equivalent of per
chloride of sodium, a
equivalent of sulphate
$Hg^2Cl + NaO,SO^3$.

At Apothecaries'
sulphuric acid to dryn
triturated with 40½ lb
of common salt are th
95 to 100 lbs. of sub
quantities of distilled w
powder.

The subliming appa
sists of a large earth
earthen elliptical recei
placed in sand contain

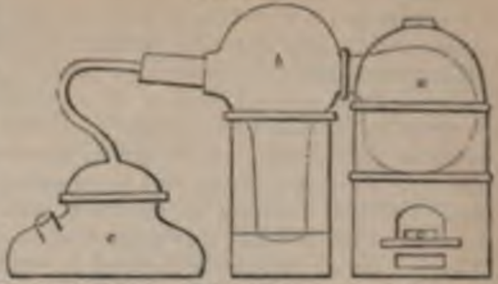
"The form in which
much upon the dime
small vessels it generall
of which is often co
transparent, and of a
acquires, by the neces
colour, more or less de
undergone. If, on the
and cold receiver, it fal
which requires only on
colourless. By a modi
to fall into water, acco

"The above circums
which calomel occasion
the buff aspect of this
though it by no mean
contains it. When th

the form of a fine powder, which is much finer than can be obtained by levigation and elutriation. This process has been improved by M. O. Henry (fig. 144).

Soubeiran[1] has proposed to modify this process, by substituting a current of air for the vapour of water; a modification which Mr. Calvert[2] states is identical with that already in use in some manufacturing houses in England. The apparatus is an iron cylinder closed at one extremity by a door through which the materials are introduced: the other extremity has a kind of neck attached to it.

FIG. 144.



Henry's Modification of Jewell's Apparatus for Preparing Calomel by Steam (hydrosublimate of mercury).

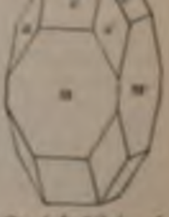
a. Furnace, containing an earthen retort (having a wide and short neck), in which the ingredients for making calomel are placed.
b. An earthen receiver, having three tubulures: one communicating with the retort, a second dipping into water in an earthen jar, and a third connected to a steam-pipe.
c. Steam-boiler.

2. Another method of preparing calomel is by precipitation. Thus when solutions of nitrate of suboxide of mercury and of chloride of sodium are mixed, double decomposition takes place; nitrate of soda is formed in solution, while dichloride of mercury, or calomel, is precipitated. "If this process be carefully performed, and the precipitate thoroughly edulcorated, the calomel is said to be sufficiently pure; but a small portion of chloride of sodium is apt to remain combined with it, which might affect its medical uses." (Brande.)

3. The late Dr. A. T. Thomson[3] took out a patent for the formation of both calomel and corrosive sublimate, by the direct union of chlorine gas and the vapour of mercury.

PROPERTIES.—The crystals of calomel are square prisms. The appearance of the crystalline cake of sublimed calomel has been already noticed. As met with in the shops, it is in the form of a fine odourless and tasteless powder, whose specific gravity is 7·140 (Boullay), 7·156 (Pelouze and Fremy). When prepared by Jewell's process, it is perfectly white, but when obtained in the ordinary way, it has a light buff or ivory tint. It volatilises by heat, and, under pressure, fuses. It is insoluble in cold water and alcohol. According to Donovan[4] and others,[5] calomel suffers partial decomposition by long boiling in water, and a solution is obtained which contains mercury and chlorine (corrosive sublimate?).

FIG. 145.



Crystal of Calomel.

By exposure to light, calomel becomes dark coloured, in consequence, according to Dumas,[6] of the transformation of

---

[1] *Chemical Gazette*, vol. i. p. 210, 1843.
[2] *Ibid.* vol. i. p. 270, 1843.
[3] *Ibid.* vol. i. p. 223, 1843.
[4] *Ann. Phil.* xiv. 323.
[5] Gmelin, *Handb. d. Chemie*, i. 1299; Geiger's *Handb. d. Pharm.* by Liebig, i. 561.
[6] *Traité de Chimie*, iii. 605.

a small portion into m
this change to the evo
oxygen. Both hypotl
this blackened calomel
change depends on th
shown to be the case
centrated hydrochloric
mercury. Boiling sul
cury, with the evolut
ammonia, it forms a d
(Kane.) But if calo
chlorine is converted i
Kane *black precipita*
amidide of mercury;

Characteristics.—
and yields a white su
sublimate of metallic li
pound. By the actio
(Hg^2O): if to the sup
is obtained, on the add
Protochloride of tin de
globules of metallic
ether.—Ed.]

Composition.—The

	Atoms.
Mercury..................	2 ...
Chlorine..................	1 ...
Subchloride of Mercury	1 ...

Purity.—When pu
or alcohol which has
change of colour on t
nitrate of silver, or hydr
of mercury may be infer
of being imperfectly was
to several patients befor
most violently. When
the quantity of sublimat
ration in the colour of th
on it, gave, with the abo
perchloride of mercury.

A whitish powder, which
black, and then, when heate
which it has been washed, o
of silver, lime-water, nor hy

Heat sublimes it without
then evaporated to dryness,
left is not turned yellow wit

PHYSIOLOGICAL EFFECTS. α. *On Animals.*—Wepfer,[1] Viborg, Flormann,[2] Gaspard,[3] and Annesley,[4] have examined the effects of calomel on dogs, horses, and pigs, but without any remarkable results. Viborg gave half an ounce, with six pounds of water, to a horse: the effects were cough, heaving of the flanks, quick pulse, enfeebled appetite, and in twenty-four hours loose stools. Annesley asserts, from his experiments on dogs, that large doses of calomel diminish the vascularity of the gastro-intestinal membrane.

β. *On Man.*—Calomel may be ranked among the milder preparations of mercury; for although, in its local action, it is somewhat more powerful than the oxide, or than those preparations which contain mercury in a finely-divided state (as blue pill), yet it is milder than most of the other salts of mercury. Introduced into the stomach through a permanent artificial opening caused by a gun-shot wound, Dr. Beaumont found that twelve grains of calomel caused commotion, slight nausea, and the secretion of a white frothy fluid running at the aperture like fermenting beer from a bottle.[5] Swallowed in *small doses*, as a few grains, it occasionally excites no obvious effects, though more commonly it acts as a purgative; and in very susceptible persons, especially females, it sometimes produces nausea, griping, and great faintness. It appears from the experience of most practitioners that adults are more susceptible of the influence of calomel than children.[6] The green stools (called *calomel stools*) which sometimes follow the administration of calomel to children, are usually supposed to arise from the action of this medicine on the liver; though Zeller (quoted by Kraus) thinks that the colour depends on alterations produced in the condition of the blood; and Kraus[7] is disposed to refer it to the operation of calomel on the milk contained in the alimentary canal.[8] But the same coloured stools are frequently observed when no mercury has been used, and there does not appear to me to be any just ground for ascribing it to calomel.[9] [Dr. Miches,[10] of Paris, has recently endeavoured to ascertain, by chemical analysis, whether the green colour of

---

[1] *Hist. Cicutæ Aquat.*

[2] Wibmer, *Wirk. d. Arzn.*

[3] Magendie, *Journ. de Physiol.*

[4] *Diseases of India.*

[5] *Experiments and Observations on the Gastric Juice and the Physiology of Digestion*, p. 182. Edinb. 1838.

[6] To this statement exceptions are frequently observed. The following is an instance of the occasional violence of the action of calomel on children. The late Dr. Thomas Davies attended, with the late Mr. Edwin Quekett, a boy of four years old, labouring under peritonitis. One grain of calomel was directed to be administered three times a day; and an aperient dose of calomel and jalap was given. On the fourth day its employment was stopped, in consequence of its violent action. The cheeks were enormously swollen, the gums sloughed, necrosis of the alveolar process of the lower jaw on each side occurred, and portions of bone, with the teeth, came away. The child ultimately recovered in about twelve months; but the jaws cannot be separated, and the patient is now obliged to suck his food through the apertures left by the loss of bone.

[7] *Heilmittellehre*, 161.

[8] See also a paper *On the Effects of Calomel in producing Slimy Stools*, in the *Lond. Med. and Surg. Journ.* April 1829, p. 344.

[9] The so-called *calomel stools* have been analysed both by Simon (*Animal Chemistry*, vol. ii. p. 386) and by Dr. Golding Bird (*Ibid.*; also *Lond. Med. Gaz.* Sept. 5, 1845): the results furnish no evidence of the supposed calomel origin of the stools. No mercury was recognised in them: Simon expressly states, that his attempts to detect mercury proved unsuccessful. These negative results favour the opinion given in the text, that the green colour of the stools is not dependent on the calomel.

[10] *Lancet*, 1849, vol. i. p. 15, quoted from *L'Union Médicale*.

and direct action on
influence, however, is
bile, are more freq
greater quantity of cl
change the chloride i
were not found to in
Like other mercuri
and thus promotes th
presume it has a simi
Neumann[1] states tha
grains of calomel, d
salivation; but three
the consequence of a
From the manner in
the disease of the pan
however, it is impossi
calomel, in small dose
preparations generally,
In *large doses*, it h
from the fatal effects
Thus Hellweg[2] has re
a laxative, caused dea
Ledelius[4] half an ounc
"Whytt, Odier, Q
calomel internally in
time; and continued i
ing the many evacuat
pains; and they affirm
agent given in these
Melancholy experience
under these large and
symptoms suddenly va

terminated in death. Still oftener I observed this unfavourable accident from an incautious use of calomel in croup: namely, where all the frightful symptoms of this tracheal inflammation, which threatened suffocation, suddenly vanish, and enteritis develope itself, which passed rapidly into gangrene, and destroyed the patients."

In the *Times* newspaper of the 26th April, 1836, there is the report of a coroner's inquest on the body of a Mrs. Corbyn, who was destroyed by swallowing 20 grains of calomel, she having previously taken a moderate dose without the medicine producing what she considered to be a sufficient effect; and in the *India Journal of Medical Science*[1] is the case of a lad, aged 14, a native of Nepal, in whom six grains of calomel apparently produced inflammation and ulceration of the mouth, enormous swelling of the face, mercurial fœtor of the breath, mortification, and death. There was no ptyalism.

In Pierer's *Annalen* for April 1827[2] is the case of a lady, who by mistake swallowed 14 drachms of calomel at once. Acute pains in the abdomen came on, accompanied by frequent vomiting and purging. These symptoms were allayed by oleaginous demulcents: but, on the second day, salivation and ulceration of the mouth took place. In three weeks, however, she was perfectly recovered. Other violent effects are noticed by Witmer, Gmelin, and others; but the instances adduced are sufficient to show that dangerous and even fatal effects may result from large doses, and therefore that Teichmeyer, Buchner, and others, are justified in ranking it among poisons.

Of late years, however, immense quantities of calomel have been administered medicinally, without giving rise to any symptoms of irritant poisoning, —nay, apparently with the opposite effect; for we have the concurrent testimony of many practitioners, that in yellow fever, cholera, and other dangerous diseases, calomel, in doses of a scruple and upwards, allays vomiting and purging; and on this account has been denominated a *sedative*. So that while in small doses (as from two or five grains) calomel is almost universally admitted to be an irritant to the bowels, it is asserted that larger ones are actually sedative. These statements appear to me to be almost inconsistent, and yet they are fair deductions from the experience of numerous intelligent practitioners. We must, therefore, endeavour to accumulate more facts, in order to illustrate the effects of calomel, and for the present confess we have very imperfect information respecting the nature of its action.

In a case published by Mr. Roberts,[3] an ounce of calomel was swallowed by mistake, and retained on the stomach for two hours before the error was discovered. The only effects were slight nausea and faintness. Subsequently, emetics, lime-water, and purgatives, were administered; calomel was vomited up, and the day but one afterwards the patient was quite well. Neither salivation nor the slightest affection of the gums occurred. The largest quantity of calomel given as a medicinal agent, at one dose, is, I believe, three drachms; "and it was followed," says Dr. Christison,[4] from whom I quote the case, which occurred in America, "by only one copious evacuation, and that not till after the use of an injection." I have now before me reports of eighteen cases of spasmodic cholera, admitted in the year 1832 into the Cholera Hos-

---

[1] *Lond. Med. Gaz.* xviii. 484.

[2] Quoted by Witmer, *op. cit.* 72.

[3] *Lond. Med. Gaz.* xxii. 611.

[4] *Treatise on Poisons.*

pital at Bethnal Gre
calomel were employ
one of my pupils), w
brought into the hos
and afterwards one
produced. In 17 ou
and purging diminish
from 20 to 30 drachm
In one case (a female
forty-eight hours; m
cessful case which I h
within forty-two hou
tells us, that in sever
doses, to the amount
salivation; and I rec
gave two drachms wit
affecting the system."
recorded by Hellweg,
appear to me to be i
in those cases in whic
corrosive sublimate.

[On the other hand
experience, the curat
when small doses are
each subsequent epide
of small and repeated
and College of Physi
result of long experien
this disease. Calome
of pills, containing o
minutes, during the st
it is given in still smal
grain of opium.—Ed.]

Mr. Annesley[3] acco
stools after the use of
becomes distended in c
which the mouth of th
calomel acts chemically
is, I think, devoid of fo

Uses.—Calomel is
affections, chronic skin
organs, more particula
derangement. For this
alteratives, as in the well

It is very frequently
uncertainty of its cath

---

combination with other drastic purgatives—such as jalap, scammony, or compound extract of colocynth, the activity of which it very much promotes. We employ it for this purpose when we are desirous of relieving affections of other organs, on the principle of counter-irritation. Thus in threatened apoplexy, in mental disorders,[1] in dropsical affections, and in chronic diseases of the skin. In torpid conditions of the bowels, where it is necessary to use powerful cathartics to produce alvine evacuations, as in paralytic affections, it is advantageously combined with other purgatives. Sometimes we use it to promote the biliary secretion—as in jaundice and other affections of the liver, in chronic skin diseases, and in various disordered conditions of the alimentary canal not accompanied by inflammation. Moreover, in the various diseases of children requiring the use of purgatives, it is generally considered to be very useful; and its being devoid of taste is of course an advantage.

As a *sedative* it has been administered in yellow fever, spasmodic or malignant cholera, dysentery and liver affections. Dr. Griffin[2] asserts that calomel proved a most successful medicine in cholera, controlling or arresting its progress in 84 cases out of 100, when administered while the pulse was perceptible at the wrist; but that, on the contrary, it proved detrimental when given in collapse. The practice was tested in 1,448 cases. The dose was from one to two scruples every hour or half-hour.

As a *sialogogue*, it may be used in the cases in which I have already stated that mercurials generally are employed: with the view of preventing irritation of the alimentary canal, it is usually given in combination with opium, unless the existence of some affection of the nervous system contraindicates the use of narcotics. This combination is employed in peripneumonia, pleuritis, croup, laryngitis, hepatitis, enteritis, and other inflammatory diseases: in fever, syphilis, and chronic visceral diseases.

Calomel is frequently combined with other medicines to increase their effects; as with squills, to produce *diuresis*, in dropsy; or with antimonials, to promote *diaphoresis*.

As an *anthelmintic* it is in frequent use, and forms one of the active ingredients of many of the nostrums sold for worms; though it does not appear to have any specific influence over parasitic animals.

The *local uses* of calomel are numerous. In diseases of the Schneiderian membrane, it is applied as a snuff. It is sometimes blown into the eye, to remove spots on the cornea. Dr. Fricke[3] has used it with great success in chronic cases of rheumatic, catarrhal, and scrofulous ophthalmia; but in two instances bad consequences resulted from its use. It is sometimes suspended in thick mucilage, and used as a gargle in venereal sore-throat, or injected into the urethra in blennorrhœa. Now and then it is used as a substitute for cinnabar in fumigation. As a local application, in the form of ointment, calomel is one of the most useful remedies we possess for the cure of several forms of chronic skin diseases.

ADMINISTRATION.—When used as an *alterative*, it is given in doses of from half a grain to a grain, frequently combined with oxysulphuret of anti-

---

[1] *Lond. Med. Gaz.* iii. 692.

[2] *Ibid.* xxi. 880.

[3] *Ibid.* xxii. 397.

mony (as in *Plummer's Pill*) or antimonial powder, and repeated e
every other night; a mild saline laxative being given the following mo
As a *purgative*, from two to five grains are given usually in combi
with, or followed by, the use of other purgatives, especially jalap,
scammony, or colocynth. As a *sialogogue*, it is exhibited in doses of
three or four grains, generally combined with opium or Dover's p
twice or thrice a day. As a *sedative*, the dose is from a scruple to
drachm or more. Biett[1] has sometimes employed it as an *errhine*, in
litic eruptions. It is mixed with some inert powder, and given to the
of from 8 to 20 grains daily. The use of acids with calomel freq
occasions griping. Calomel is most extensively employed in the disea
children, and may be given to them in as large or proportionally larger
than to adults. Salivation is a rare occurrence in them: indeed, Mr.
asserts, that mercury *never* produces ptyalism, swelling or ulceration
gums, in infants; but this is an error.

1. **PILULA HYDRARGYRI CHLORIDI COMPOSITA**, L.; *Pilulæ Calome
compositæ*, E. D.; *Compound Calomel Pills*. (Calomel; Oxysul
of Antimony, each ʒij.; Guaiacum, powdered, Treacle, of each ℥ss.
the calomel with the oxysulphuret of antimony, afterwards with the gua
and the treacle, until incorporated, *L.*—The *Edinburgh College* u
Calomel, and Golden Sulphuret of Antimony, of each, *one part*; Guai
fine powder, and Treacle, of each *two parts*; the pill-mass is ordered
divided into six-grain pills.—The *Dublin College* employs of Calomel
cipitated Sulphuret of Antimony, of each ʒj.; Guaiacum Resin, in p
ʒij.; Castor Oil, fʒj. Triturate the calomel with the antimony, then a
resin and the oil, and beat the whole into a uniform mass).—This com
is commonly known as *Plummer's pill* (*pilulæ Plummeri*) having be
mitted into the Edinburgh Pharmacopœia at his recommendation. C
and precipitated tersulphuret of antimony mutually but slowly react o
other; and the ultimate products are sulphuret of mercury and terch
of antimony. In the dry state, and mixed with other ingredients, this c
is retarded. These pills are frequently employed as alteratives in c
skin diseases, in the papular and pustular forms of the venereal disea
chronic liver affections, and in various disordered conditions of the dig
organs. [One grain of calomel is contained in six grains of the Londo
Edinburgh, and in five grains of the Dublin preparation.—Ed.] The
is from five to ten grains.

2. **PILULÆ CALOMELANOS ET OPII**, E.; *Calomel and Opium*
(Calomel, *three parts*; Opium, *one part*; Conserve of Red Roses, *a
ciency*. Beat them into a proper mass, which is to be divided into
each containing two grains of calomel).—Each pill contains two-thirds
grain of opium. It is a valuable compound in rheumatism and various
inflammatory diseases. Dose, one or two pills. If ptyalism be required
pill may be repeated three times daily.

3. **UNGUENTUM HYDRARGYRI CHLORIDI**; *Calomel Ointment*. (Cal

---

[1] *Lond. Med. Gaz.* viii. p. 540.
[2] *Pract. Observ.* 281.

ʒj.; Lard, ℥j.)—This is a most valuable application in porrigo favosa, impetigo, herpes, and the scaly diseases (psoriasis and lepra). Indeed, if I were required to name a local agent pre-eminently useful in skin diseases generally, I should fix on this. It is well deserving a place in the Pharmacopœia.

4. **PILULÆ CATHARTICÆ COMPOSITÆ**, Ph. of the United States. *Compound Cathartic Pills.* (Compound Extract of Colocynth, ℥ss.; Extract of Jalap, in powder; Calomel, of each, ʒiij.; Gamboge, in powder, ℈ij. M. Divide into 180 pills).—This pill is intended to combine smallness of bulk with efficiency and comparative mildness of purgative action, and a peculiar tendency to the biliary organs.[1] Each pill contains one grain of calomel. Three pills are a full dose.

179. HYDRARGYRI PERCHLORIDUM.—PERCHLORIDE OF MERCURY.

Formula HgCl. *Equivalent Weight* 135·5.

HISTORY.—We have no account of the discovery of this preparation. Geber[2] described the method of preparing it; but it is supposed to have been known long anterior to him. Like calomel, it has had various synonymes, of which the principal are the following:—*chloride, bichloride, hydrochlorate, muriate* or *oxymuriate of mercury* (*hydrargyri chloridum, bichloridum*, L., *hydrochloras, murias* vel *oxymurias*), *corrosive sublimate* (*sublimatus corrosivus*, E., *sublimatum corrosivum*, D.), *corrosive muriate of mercury* (*hydrargyri murias corrosivus*), and *acidum chlorohydrargyricum.*

PREPARATION.—There are several methods of obtaining it. Of these two only will require notice.

1. By subliming a mixture of persulphate of mercury and common salt.

The *London College* orders of Mercury, lb. ij.; Sulphuric Acid, f℥xxiss.; Chloride of Sodium, lb. iss. Boil down the mercury with the sulphuric acid in a proper vessel, until dry bipersulphate of mercury remains; rub this when it is cold with the chloride of sodium in an earthen mortar; then sublime with a heat gradually raised.

The *Edinburgh College* directs of Mercury, ℥iv.; Sulphuric Acid (commercial), f℥ij. and fʒij.; Pure Nitric Acid, fʒss.; Muriate of Soda, ℥iij. Mix the acids; add the mercury; dissolve it with the aid of a moderate heat; then raise the heat so as to obtain a dry salt. Triturate this thoroughly with the muriate of soda; and sublime in a proper apparatus.

The *Dublin College* gives a separate formula for the preparation of the bipersulphate of mercury (*Hydrargyri Sulphas*, D.) (See *ante*, *Hydrargyri Persulphas*, p. 918.)

Take of Sulphate of Mercury, lb. x.; Dried Chloride of Sodium, lb. v. Reduce each salt to a fine powder, and, having mixed them carefully by trituration in a mortar, let the mixture be introduced into an iron pot lined with clay, and by a regulated heat, applied through the intervention of sand, let the corrosive sublimate be sublimed into an earthen head placed over the pot, and connected to it by means of lute. The product should be preserved in an opaque bottle.

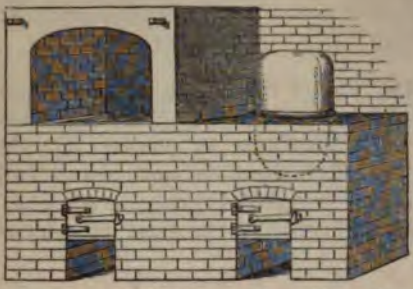
Sulphate of mercury is usually prepared by submitting the sulphuric acid and mercury to heat in an iron pot, set in brickwork, over a proper fire,

---

[1] *United States Dispensatory.*

[2] *Inv. of Ver.* viii. 252.

FIG. 146.



Furnaces for the Preparation of Corrosive Sublimate.

a. Furnace for the preparation of the persulphate of mercury. When the operation is going on, an iron plate is suspended in front of the hood, to prevent the escape of vapour.
b. Furnace for the sublimation of the perchloride.

and under a hood or chimn carry off the vapour of sulph acid (fig. 146 *a*).

The mixture of sulphate an mon salt is subjected to sublin in an earthen alembic placed i contained in an iron pot; or iron pot lined with clay, and c by an inverted earthen pan fig. 146 *b*). The same pot, different head, may be used preparation of calomel.

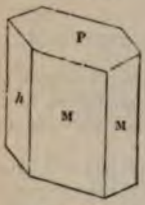
The nature of the changes occur in the manufacture of phate of mercury have been explained.

When this salt is sublime chloride of sodium, double d position takes place, and we perchloride of mercury and sulphate of soda, HgO,SO^3 + N $HgCl + NaO,SO^3$.

2. Perchloride of mercury may also be procured by the direct union constituents, chlorine and mercury. The late Dr. A. T. Thomson[1] to a patent for this process.

PROPERTIES.—As usually met with in commerce, perchloride of merc a semi-transparent crystalline mass, in which perfect crystals are rarely Occasionally, however, they are obtained either by slow limation, or from a solution of the salt. Their form right rhombic prism. Their specific gravity is abou (5·14 to 5·42, Liebig). The taste of this salt is acrid pery, and persistent. When heated in a tube it fuses, and volatilises: the vapour is very acrid. [If heat platina foil, or on a slip of mica, it is, if pure, entirely limed.—ED.] It is soluble in about three times its of boiling and in about eighteen or twenty times its of cold water: the acids (especially hydrochloric) an alkaline chlorides increase its solubility. It is solub seven parts of cold or three and a half parts of boiling al Ether dissolves it more readily than alcohol, and will separate it from its watery solution; and hence it is sometimes employ remove it from organic mixtures.

FIG. 147.



Crystal of Perchloride of Mercury.

An aqueous solution of perchloride of mercury readily undergoes deco sition, especially when exposed to solar light; calomel is precipitated, hydrochloric acid set free. This change is facilitated by the presence of nic substances,—as gum, extractive, or oil; whereas it is checked by presence of alkaline chlorides.

Albumen forms a white precipitate with an aqueous solution of perchl of mercury. This precipitate is slightly soluble in water, and consist cording to Lassaigne,[1] of albumen, 93·45, and perchloride of mercury, 6·55. But, according to the experiments[2] of Rose, Geoghegan, Mulder, Marchand, and Elsner, it consists of from 10·278 to 11·192 of oxide of mercury, and from 89·722 to 88·808 of albumen. Fibrin forms a similar white compound with corrosive sublimate. When albuminous and fibrinous textures are immersed in a solution of this salt, combination takes place, the tissue contracts, increases in density, becomes whiter, and does not putrefy. Hence it is employed by the anatomist for hardening and preserving certain parts of the body—as the brain.

---

[1] *Chemical Gazette*, vol. i. p. 223, 1843.

A solution of perchloride of mercury possesses some of the characters of an acid. Thus its solution reddens litmus, and it unites with the chlor-bases (as chloride of sodium), forming the double salts called *hydrargyro-chlorides*. Litmus which has been reddened by a solution of perchloride of mercury has its blue colour restored by chloride of sodium.

Characteristics.—Perchloride of mercury is recognised by the following characters:—

α. *Heated* in a tube by a spirit lamp, with caustic, or the carbonated fixed alkalies, an alkaline chloride is formed, oxygen, and, if a carbonate be used, carbonic acid gas is evolved, and metallic mercury is sublimed and condensed in the form of globules on the sides of the tube. [The fused residue in the tube, if dry carbonate of soda be used, is chloride of sodium. This may be dissolved in water acidulated with nitric acid, and then tested by nitrate of silver. In this way the presence of chlorine as the combining ingredient of the mercury is established.—ED.]

β. *Lime-water* causes a lemon-yellow precipitate (*hydrated red oxide of mercury*). The supernatant liquid, acidified with nitric acid, yields with nitrate of silver a white precipitate ($AgCl$) insoluble in excess of nitric acid. If the perchloride be in excess, the precipitate is brick-red (*oxichloride of mercury*, $HgCl,3HgO$).

γ. *Caustic ammonia*, added to a solution of the perchloride, causes a white precipitate (*chloro-amidide of mercury*, $HgCl,HgAd=Hg^2,Cl,NH^2$).

δ The *alkaline mono-carbonates* throw down a brick-red precipitate ($HgCl,3HgO$); the *alkaline bicarbonates* cause opalescence, but no immediate precipitate; in a few minutes, however, a dark-reddish precipitate ($HgCl,3HgO$) is formed.

ε. *Iodide of potassium* occasions a scarlet precipitate (HgI) soluble in excess, either of iodide of potassium, or of perchloride of mercury; the precipitate frequently appears at first of a yellow colour, though it quickly becomes scarlet.

ζ. *Protochloride of tin* added in excess to perchloride of mercury causes first a white precipitate (*calomel*), and afterwards a greyish powder, composed of reguline mercury, which falls down in a finely divided state. $HgCl+SnCl=Hg+SnCl^2$.

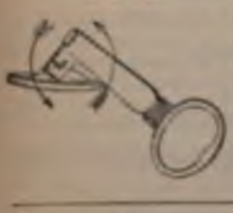
η. *Hydrosulphuric acid* in excess passed through a solution of perchloride of mercury, occasions a black precipitate (HgS). If the perchloride be in excess, a white precipitate (*chloro-sulphuret of mercury*, $2HgS,HgCl$) is obtained.

ϑ. *Ferrocyanide of potassium* causes a white precipitate (*ferrocyanide of mercury*).

ι. *Albumen* causes a white precipitate when added to a solution of corrosive sublimate.

κ. *Galvanism.*—Drop the suspected solution on a piece of gold (as a sovereign), and apply a key, so that it may touch, simultaneously, the gold and the solution: an electric current is immediately produced, the perchloride is decomposed, the mercury attaches itself to the negative electrode (or pole), namely, the gold, while the chlorine unites with the iron of the positive electrode (or pole) to form chloride of iron. The relative position of the gold, the key, and the solution, will be evident from the fig. 148, and the arrows point out the direction of the electric current. The silver stain left on the gold is readily removed by heat. [The same result is produced by placing the solution on

FIG. 148.



---

[1] *Journal de Chim. Méd.* iii. 2e sér. 161.

[2] Sobernheim, *Physiologie der Arzneiwirkungen*, p. 67, 2te Aufl. 1843.

a piece of polished copper foil, slightly acidulating it with dilute hydrochloric a then touching the copper, through the solution, with a slip of zinc. Mercury is in deposited.

The tests upon which reliance can be placed for the detection of *mercury* as a in water or organic liquids, are few and simple in their application. If *corrosive* be dissolved in a liquid, we may mix this liquid in a bottle with its volume of agitate the vessel for a few minutes, then pour the ethereal portion of the liquid watch or dial glass, and allow it to evaporate spontaneously. If corrosive sublim present, there will be a residue of fine white prismatic crystals on the watch glass. residue may be examined by the microscope, and also chemically by touching th talline deposit with a glass rod dipped in a moderately strong solution of io potassium. The production of a scarlet colour will indicate that the crystals are t a persalt of mercury; and the presence of chlorine may be readily detected by the pr described in the text.

The detection of *mercury* in the liquid is readily effected by the following pro Acidulate the liquid with hydrochloric acid, warm it, and then immerse in it a fine copper gauze, such as is used in Reinsch's process for the separation of arse the copper gauze be tarnished, it should be washed in water and ether, dried and in a small tube, when, should the tarnish have been caused by mercury, silvery g white by reflected and opaque by transmitted light, will be apparent. If there difficulty, owing to the smallness of the sublimate, in determining whether it con globules of mercury or not, the following corroborative test may be resorted to:— the ring of glass holding the sublimate, break it up, and heat it in a wide tube by of a sand bath in a few drops of nitro-hydrochloric acid. Evaporate to dryness. talline sublimate will appear on the glass (corrosive sublimate), the nature of whi be determined by touching the crystals with a rod dipped in a solution of iodide o sium. If the crystals be owing to corrosive sublimate produced by the action mixed acids on the globules of metallic mercury, the brilliant scarlet colour of i mercury will be immediately apparent.

Another process for the galvanic separation of mercury by gold and zinc is give AURUM, *post*.

The separation of mercury alone does not prove the presence of corrosive sub but if this poison has been really taken, there will be evidence of the fact in the n the symptoms and post-mortem appearances.

Another mode of detecting mercurial salts, whether in substance or solution, h lately proposed by Mr. Morgan.[1]

If a strong solution of iodide of potassium be added to a minute portion of an salts of mercury placed on a clean bright plate of copper, the mercury is imm deposited in the metallic state, appearing as a silvery stain on the copper, which be mistaken, as no other metal is deposited by the same means. By this method sive sublimate may be detected in a solution, unaffected by caustic potash or io potassium. The two-hundredth part of a grain of calomel, or the four-hundredth a grain of peroxide of mercury, may be detected by this means.

The advantages of this test are:—1st, its delicacy, inferior only to the galvanic zinc and gold; 2nd, its easy application, and its certainty. If applied to a soluti latter must be concentrated; for instance, although it will detect 1000th of a gr drop of water, it will not do so in a drachm. We do not find that this proc separating mercury possesses any advantages over that above recommended.—ED.]

COMPOSITION.—The composition of this salt is as follows:—

	At.	*Eq. Wt.*	*Per Ct.*	*Turner.*		*Vols.*
Mercury	1	100	73·8	73·53	Vapour of mercury	1
Chlorine	1	35·5	26·2	26·47	Chlorine Gas	1
Perchl. of Mercury	1	135·5	100·0	100·00	Vapour of Corrosive Sublimate	1

PURITY.—Pure perchloride should be white, dry, totally vapourised by and completely soluble in water, alcohol, or ether.

---

[1] *Edinburgh Monthly Journal*, vol. xiv. p. 267.

It is crystalline, liquefies by heat, and sublimes. It is soluble in water, rectified spirit and sulphuric ether. Whatever is thrown down from water, either by solution of potash, soda, or lime water, is of a reddish colour: or, if a larger quantity of alkali be added, it is yellow. This substance by heat emits oxygen, and runs into globules of mercury.—*Ph. Lond.*

It sublimes entirely by heat; and its powder is entirely and easily soluble in sulphuric ether.—*Ph. Ed.*

PHYSIOLOGICAL EFFECTS. α. *On Vegetables.*—The effects of solutions of perchloride of mercury on plants have been examined by Seguin, and subsequently by Marcet and Macaire;[1] and from their experiments it appears, that when growing plants are immersed in a solution of this salt, part of the poison is absorbed, a change of colour takes place in the leaves and stems, and death is produced. It is equally poisonous to cryptogamic plants. Hence vegetable tissues soaked in a solution of it are no longer adapted for the development of the *Merulius lachrymans*, and of other fungi known under the name of the *dry rot*. This, in fact, is the principle adopted by Mr. Kyan[2] for the preservation of timber, and which is now practised by the *Anti Dry Rot Company.*[3]

β. *On Animals generally.*—The effects of corrosive sublimate on animals have been examined by Ettmuller, Wepfer, Sprœgel, Sir Benjamin Brodie,[4] Campbell, Lavort, Smith, Gaspard, Orfila[5], Schubarth, and Bostock. An abstract of these may be found in the works of Wibmer[6] and Christison.[7] Dogs, cats, horses, rabbits, and frogs, are the animals on which the experiments have been tried, and on which sublimate has been found to exercise a poisonous operation; and the same kind of effect is presumed, from analogy, to be produced on all other animals. The results of these experiments have been so briefly yet clearly stated by Dr. Christison, that I cannot do better than quote his words:—"Corrosive sublimate causes, when swallowed, corrosion of the stomach; and, in whatever way it obtains entrance into the body, irritation of that organ and of the rectum, inflammation of the lungs, depressed action, and perhaps also inflammation of the heart, oppression of the functions of the brain, and inflammation of the salivary glands." I may add, that mercurial fœtor and salivation have been observed in horses, dogs, and rabbits.

γ. *On Man.*—αα. *In small or therapeutic doses*, as from one-eighth to one-fourth of a grain, it frequently exerts a beneficial effect on diseases (syphilitic eruptions, for example), without producing any obvious alteration in the actions of the different organs. Occasionally, especially when the stomach and bowels are in an irritable condition, it gives rise to a sensation of warmth in the epigastrium, and causes nausea, griping, and purging. In such cases it is best to diminish

---

[1] De Candolle, *Phys. Vég.* 1832.

[2] *Lond. Med. Gaz.* xvi. 630. *Vide* also Dr. Dickson's *Lecture on Dry Rot*, Lond. 1837.

[3] See Kerandren, *Des Propriétés du Sublimé Corrosif pour la conservation du bois, et des effets de cette préparation sur la santé des marins*, in the *Mém. Royale Acad. de Méd.* t. v. p. 41, Paris, 1846. I have seen wood which had been prepared by Kyan's process, and which became black on the application of hydrosulphuret of ammonia (showing the presence of mercury), covered with cottony fungi which grew from it. Sir John Barrow, in his *Life of Lord Anson*, says, wood thus prepared is attacked by the Teredo.

[4] *Phil. Trans.* for 1812.

[5] *Toxicol. Gén.*

[6] *Wirk. d. Arzn. u. Gifte.*

[7] *Treatise on Poisons.*

the dose, and conjoi
pulse becomes some
is oftentimes brough
Continued use of it
coincide in this sta
occasion this effect t
who, from the year
venereal disease, at
remedy, says that no
symptoms, in conseq
and careful in its en
first appearance of
repeated experience,
of this remedy."

ββ. *Chronic pois*
continued use of th
the usual constitutio
griping pain in the a
loss of appetite, naus
gastro-enteritic symp
become affected ; th
disordered respiratio
with the effects said
corrosive sublimate,
patients affected with
Swieten gives ; "for
troubled with a coug
subject to hemorrhag

γγ. *Acute poisoni*
caustic poison, in virt
of the tissues. I s
poisoning by it, in o
violent irritation of t
are at first the same a
salivation and inflam
incident to mercurial

First variety : Gastro-e
of other corrosive poison
and stomach ; difficulty
(increased by every thin
matters. The pain soon
acutely sensible to the sli
anxiety ; flushed counte
sweats ; burning thirsts ;
and, lastly, various indica
tendency to stupor, or ev
and extremities : sometim
body ; or even paraplegia.
produced on the nervous

---

[1] Van Swieten's

Dr. Christison points out the following characters as serving to distinguish poisoning by perchloride of mercury from that by arsenious acid:—

1. The symptoms begin much sooner.
2. The taste is much more unequivocal and strong.
3. The acridity and irritation in the gullet is much greater.
4. The countenance is flushed, and even swollen; whereas, in poisoning by arsenic, it is usually contracted and ghastly.
5. Blood is more frequently discharged by vomiting and purging.
6. Irritation of the urinary passages is more frequent.
7. Nervous affections are more apt to come on during the first inflammatory stage.
8. The effects are more curable than those of arsenic.
9. Deviations in the symptoms are more rare.

To these I may add, that the whitened condition of the epithelium of the mouth distinguishes corrosive sublimate poisoning from poisoning by arsenious acid.[1]

Second variety: Gastro-enteritis, accompanied with or followed by acute erethysm.—I here use the term erethysm in the sense in which it is employed by Dr. Christison,—namely, to indicate all the secondary effects of mercury. In this variety, the symptoms first observed are those mentioned for the last variety, but they are followed sooner or later by those of inflammation of the salivary glands, and of the mouth and its neighbouring parts; profuse salivation, ulceration of the mouth, great fœtor of the breath, and other symptoms of this kind, already described.

Corrosive Sublimate eater.—Pouqueville[2] mentions as a common report that in 1800 there lived at Constantinople a man called "Suleyman yeyen," or "Suleyman the eater of corrosive sublimate." He was 100 years old, and had taken sublimate for 30 years. In 1797 his dose daily exceeded a drachm! Thornton,[3] Hobhouse,[4] and Byron[5] refer to Pouqueville's statement, but no writer that I have met with professes to have seen this extraordinary poison-eater. The story is, doubtless, entirely fabulous, or, if founded on any fact, has been greatly exaggerated. Although use may diminish the effect of agents whose active force is dynamical, there is no evidence that as a result of habit, the affinity of the metallic salts for the organic constituents of the body is lessened. I have no hesitation, therefore, in refusing credence to Pouqueville's story.

USES.—*Internally*, it has been employed as a sialogogue, alterative, and diaphoretic. The celebrated Baron Van Swieten[6] may be regarded as the principal introducer of corrosive sublimate into practice as a remedy for *venereal diseases*.[7] He seems to have been led to its employment from a suspicion that salivation was not requisite for curing this class of diseases; and hence he was desirous of obtaining some mercurial "that could be diluted at will, and so tried in a very small dose." Now corrosive sublimate possessed these properties, and hence he commenced his experiments with it, and meeting with great success, recommended it to Maximilian Locher, whose results I have already stated.[8] The balance of evidence is decidedly favourable to the employment of this medicine as an internal remedy for venereal diseases. By its partizans, it has been asserted to be a safe and efficacious mercurial for the removal of venereal symptoms in a very short space of time, and without causing

---

[1] [Oxalic acid and sulphuric acid produce, under certain circumstances, this whitened condition of the mucous membrane of the mouth.—ED.]

[2] *Voyage en Morée à Constantinople*, vol. ii. p. 126, Paris, 1805.

[3] *Present State of Turkey*, p. 295, Lond. 1807.

[4] *Journey through Albania, &c.* p. 945, 1813.

[5] *Works*, p. 765, 1837, 8vo. edition.

[6] *Op. cit.*

[7] See also several papers on the use of perchloride in syphilis, in the *Medical Observations and Inquiries*, vols. i. and ii.

[8] For further historical details respecting its use, *vide* Pearson's *Observations on the Effects of various Articles of the Mat. Med.* p. 99, *et seq.*

salivation, merely by e
hand, that other merc
by corrosive sublimat
irritant properties re
advocates for its use
using it is in the
gives the following
Corros. gr. xij., solve
Albi, aa. q. s. ut ft. p
tains one-twentieth of
daily, and increased
at a dose. The best
subjects and painful
taken with each dose.
he should adopt a su
take decoction of sars

In *acute diseases,*
however, Schwartz ga
Sauter employed it in
in asthenic malignant
to use it in fever as a

In various *chronic*
phoretic with occasion
periodical pains, skin d
system. In such it sh
saparilla,) and warm
bined with it.

Corrosive sublimate
as those arising from
liquor hydrargyri bichl
even weeks without af
seen dropsical sympto

As an *external* ren
(either alone or combi
rabid animals, and to
objectionable. In on
with an equal weight
surface of the ulcer,
saturated with tincture
purposes: thus by Ba
chronic skin disease
ulcers, particularly tho
from the urinary organ
cially those of a venere

---

[1] *Vide* Pearson, *op. cit.*
[2] *Neue zuverläss. Heilart.*
Bd. v. S. 596.
[3] Richter, *Ausf. Arzneim.*
[4] *United States Dispensat*

obstinate gleet, where the constitution is not very irritable, an injection of a solution of corrosive sublimate frequently proves most effective. A solution is sometimes used as a preventive for the venereal disease. I am informed that a most effective remedy for the contagious porrigo which spreads amongst children in schools, is an ointment composed of from gr. ss. to gr. ij. of corrosive sublimate to an ounce of lard.

ADMINISTRATION.—It may be used internally in substance or solution. The dose of it in substance is from one-sixteenth to one-eighth of a grain. Some advise it to be given to the extent of one-fourth of a grain, but in this dose it is very apt to gripe and purge. Dzondi's formula, already given, may be employed when we wish to administer it in substance. In solution, it may be exhibited dissolved in water (see *liquor hydrargyri bichloridi*), alcohol, or ether.

For *external use*, a watery solution may be employed, containing from half a grain to two or three grains, dissolved in one ounce of water. As an injection in gonorrhœa, from gr. ⅛ to ¼ may be dissolved in an ounce of water.

ANTIDOTES.—Several substances which decompose corrosive sublimate have been employed as antidotes. The most important of these are albuminous substances, the hydrated sulphuret of iron, and a mixture of iron filings and zinc.

When corrosive sublimate is mixed with *albumen*, a compound is formed whose chemical action on the tissues is slight as compared with that of perchloride of mercury. Hence the whites and yolks of eggs, milk, and a mixture of wheat-flour, oatmeal (or barley meal), and water, are used as antidotes.

Baron Thénard, the celebrated chemist, inadvertently swallowed a concentrated solution of corrosive sublimate, but by the immediate use of whites of eggs suffered no material harm. Peschier states that one egg is required for every four grains of the poison. Albumen retards, but does not prevent, the absorption of the poison, and consequently does not preclude the production of the constitutional effects of corrosive sublimate.

A mixture of two parts of finely-divided *iron* (iron filings) and one of *zinc* has been recommended by Bouchardat, with the view of reducing corrosive sublimate to the metallic state. [The only efficacious antidotal treatment consists in the free administration of albumen. For this purpose, the yolk as well as the white of egg may be freely given, mixed with water.—ED.]

Meconic acid and the *soluble meconates*, though by some supposed to be antidotes, have been shown by Mr. Allchin[1] not to be so in reality. That *opium* is a valuable agent in poisoning by this mercurial salt cannot be doubted; but its efficacy, though perhaps in part chemical, is chiefly dynamical. Its resinous and colouring matter, as well as, perhaps, to a certain extent, its meconic acid, forms, with corrosive sublimate, difficultly soluble compounds. But its narcotic influence, by deadening the sensibility of living parts to the action of irritants, is the chief source of the utility of opium in poisoning by corrosive sublimate.

LIQUOR HYDRARGYRI BICHLORIDI, L.; *Solution of Bichloride of Mercury*. (Take of Bichloride of Mercury, Hydrochlorate of Ammonia, each, grs. x.; Distilled Water, Oj. Dissolve the bichloride of mercury and

---

[1] *Pharmaceutical Journal*, vol. viii. p. 264, 1848.

hydrochlorate of ammonia together in water).—Hydrochlorate of amm
used to increase the solvent power of the water. Each fluidounce co
half a grain of corrosive sublimate. The dose of this solution is from
fluidrachm to two or three fluidrachms, taken in some bland liquid, as
tea.

180. HYDRARGYRI AMIDO-CHLORIDUM.—AMI
CHLORIDE OF MERCURY.

Formula $Hg^2,Cl,N,H^2=HgCl,HgAd$. *Equivalent Weight* 251·5.

HISTORY.—This compound was discovered by Raymond Lully i
thirteenth century. Lemery pointed out two modes of procuring it, and
it is sometimes termed *Lemery's white precipitate*, to distinguish it
precipitated calomel, also called on the continent "white precipitate."
had various other appellations, as *cosmetic mercury* (*mercurius cosme*
white precipitated mercury (*hydrargyrum præcipitatum album*, E.)
according to the view taken of its composition, it has been called *muri*
ammonia and mercury, *ammoniated submuriate of mercury* (*hydr*
submurias ammoniatum), *ammoniated mercury*, *ammoniacal oxychl*
of mercury, and *ammonio-chloride of mercury* (*hydrargyri amm*
chloridum, L. D.) It is popularly called *white precipitate*, or *white*
of mercury.

PREPARATION.—All the British Colleges give formulæ for the prep
of this salt.

The *London College* orders of Bichloride of Mercury, ℥vj.; Distilled Water,
Solution of Ammonia, f℥viij. Dissolve the Bichloride of Mercury, with the appl
of heat, in the water. To this, when it is cold, add the Ammonia, frequently s
Wash the powder thrown down until it is free from taste; lastly, dry it.

The *Edinburgh College* directs of Corrosive Sublimate, ℥vj.; Distilled Water,
Aqua Ammoniæ, ℥viij. Dissolve the corrosive sublimate with the aid of heat
distilled water; and when the solution is cold add the aqua ammoniæ; stir the
well; collect the powder on a calico filter, and wash it thoroughly with cold water.

The *Dublin College* gives the following directions for its preparation:—Take of
sive Sublimate, ℥j.; Solution of Ammonia, f℥ix.; Distilled Water, Oj. Disso
corrosive sublimate in the water, with the aid of a gentle heat, pour the ammonia in
solution, and, having stirred the mixture well, collect the precipitate on a filter, an
it with warm distilled water, until the liquid which passes through ceases to give a
pitate when dropped into an acid solution of nitrate of silver. Lastly, dry the prod
a temperature not exceeding 212°.

By the addition of ammonia to a solution of perchloride of mercury, a
precipitate of the amido-chloride of mercury is formed, while there rema
solution half the chlorine of the perchloride combined with hydroge
ammonia, as sal ammoniac. $2HgCl+2NH^3=HgCl,HgAd+NH^3,HCl$

PROPERTIES.—Amido-chloride of mercury occurs in commerce in mas
in powder. It is white, inodorous, has a taste at first earthy, after
metallic. It is decomposed and dissipated by heat, giving out amm
nitrogen, calomel, and water. It is insoluble in alcohol. By boiling in
we obtain a solution of hydrochlorate of ammonia, and a heavy yellow po
($HgCl,2HgO,HgAd$), which is insoluble in water. It is soluble in sulph
nitric, and hydrochloric acids.

Characteristics.—When heated with caustic potash, it gives out amm and forms a yellow powder (*white precipitated mercury and peroxide of mercury*, KANE). The solution contains chloride of potassium, and with nitrate of silver yields a white precipitate (AgCl), insoluble in nitric acid, but soluble in ammonia. Caustic ammonia does not alter white precipitate. By this it may therefore be distinguished from calomel, which yields a grey powder on the addition of ammonia. Protochloride of tin decomposes white precipitated mercury, and separates metallic mercury. To these characters must be added the effect of heat, water, and acids, as above mentioned.

COMPOSITION.—Amido-chloride of mercury has the following composition:—

	At.	*Eq.Wt.*	*Per Ct.*	*Kane.*[1]	*Riegel.*
Mercury	2	200	79·522	78·60	78·85
Chlorine	1	35·5	14·113	13·85	13·86
Nitrogen	1	14	5·566	6·37	6·35
Hydrogen	2	2	0·795		
Amido-Chloride of Mercury	1	251·5	99·996	98·82	99·06
			HO	0·58	
				99·40	

Or	*At.*	*Eq.Wt.*	*PerCt.*
Perchloride of Mercury	1	135·5	53·876
Amidide of Mercury	1	116	46·123
Amido-Chlor. of Mercury.	1	251·5	99·99

According to Hennel[2] and Mitscherlich[3] its composition is $2HgCl,NH^3HCl$. Mr. Phillips[4] regards it as a compound of $HgCl,HgO,NH^3$.

PURITY.—This compound is largely adulterated with sulphate of lime. One sample was found to contain one-third of its weight of this substance. Carbonate of lime and of lead are sometimes employed to mix with it.[5] Pure white precipitate, heated on platina or a slip of mica, is dissipated without any residuum; whereas the above impurities remain. The carbonates are recognised by their effervescence on the addition of hydrochloric acid. Sulphate of lime may be detected by boiling the suspected substance in distilled water, and applying the tests for sulphates and calcareous salts, as before directed.

A white powder totally sublimed by heat. It is dissolved in hydrochloric acid without effervescence. When heated with solution of potash it becomes yellow, and emits ammonia.—*Ph. Lond.*

Iodide of potassium is sometimes employed to detect lead or starch in the acetic solution. If lime-water or ammonia occasions a black precipitate, or blackens the powder, it indicates the presence of a protosalt of mercury.

PHYSIOLOGICAL EFFECTS.—Its action on the body is very imperfectly known, no recent experiments having been made with it. It is usually considered to be highly poisonous, and somewhat similar in its operation to perchloride of mercury. Palmarius and Naboth[6] have reported fatal cases of its use.[7]

USES.—It is employed as an external agent only; commonly in the form of an ointment. It is an efficacious application in various skin diseases—as porrigo, impetigo, herpes, and even scabies; also in ophthalmia tarsi. Among the lower classes it is commonly used to destroy pediculi.

---

[1] *Trans. of the Royal Irish Academy*, vii. 423.

[2] *Quarterly Journal of Science*, xviii. 297.

[3] *Ann. Chim.* xxxv. 428

[4] *Translation of the London Pharmacopœia.*

[5] [Mr. G. R. Barnes found a sample of this drug to be adulterated with fifty per cent. of carbonate of lime. *Pharm. Journ.* 1849-50, p. 240.)—ED.]

[6] Wibmer, *Wirk. d. Arzn.* iii. 64.

[7] Vide also Gmelin, *App. Medicam.* ii. 166.

ANTIDOTE.—[Albumen. The speedy expulsion of the poison from stomach.—ED.]

UNGUENTUM HYDRARGYRI AMMONIO-CHLORIDI, L.; *Unguentum Pr tati albi*, E.; *Ointment of White Precipitate.* (Ammonio-Chlori Mercury, ʒij.; Lard, ℥iij.; White Precipitate, ʒij.; Lard, ℥iij. Mi —Stimulant, alterative, and detergent. Used in various skin diseas above mentioned.

181. HYDRARGYRI IODIDA.—IODIDES OF MERCU

Three compounds of mercury and iodine are known. They are as fol

Subiodide of Mercury (*protiodide*)	Hg^2I
¾ Iodide (*sesquiodide*)	Hg^4I^3
Periodide (*biniodide*)	HgI

Of these the first and the third are used in medicine.

1. Hydrargyri Subiodidum.—Subiodide of Mercury.

Formula Hg^2I. *Equivalent Weight* 326.

HISTORY.—This compound is commonly called *protiodide of me (hydrargyri iodidum*, L.), or simply *iodide of mercury (hydra iodidum*). It may be distinguished also as *green subiodide of me (hydrargyri subiodidum viride*, D.)

PREPARATION.—There are several methods of preparing it.

The *London* and *Dublin Colleges* order of Mercury, ℥j.; Iodine, ʒv.; Rectified *as much as may be sufficient*. Rub the mercury and iodine together, adding the gradually, until globules are no longer visible. Dry the powder immediately, gentle heat, (at a temperature not exceeding 100° *D*.), without the access of ligh keep in a well-stoppered vessel.

The *Edinburgh College* gives no formula.

In this process the mercury and iodine enter into combination. The hol facilitates the union by dissolving a portion of iodine, and forming the remainder a pasty mass. Some red or periodide is usually first fo and is afterwards transformed into the green or subiodide by uniting mercury.

This process succeeds well when small quantities of iodide are to be pared; but it is scarcely applicable to the preparation of large quant owing to the great heat which is evolved, by which iodine is volatilised, some red or periodide formed. Soubeiran[1] says that the mass somet inflames, and escapes from the mortar with a kind of explosion. To these inconveniences, small quantities only (seven or eight ounces, for exa should be prepared at one time, and the quantity of alcohol should be mented. Another mode of preparing it is by the addition of solution of i of potassium to a solution of the suboxide of mercury, acidified with a small quantity of nitric acid, as long as a greenish precipitate is prod There are, however, some difficulties in this mode of proceeding. A nitrate of mercury is apt to be precipitated with the subiodide, and if, to avoid this, we use excess of nitric acid, this decomposes the iodide of potassium, and sets iodine free, which combines with the subiodide to form the red or periodide. If the solution of protonitrate be added to that of the iodide of potassium, metallic mercury and red or periodide are apt to be formed: the latter is at first dissolved, but is afterwards deposited with the subiodide.

---

[1] *Nouveau Traité de Pharmacie*, t. ii. p. 513, 2nde édit.

PROPERTIES.—It is a dingy green powder, whose sp. gr. is 7·75. It is insoluble in water, alcohol, or an aqueous solution of chloride of sodium; but is soluble in ether, and slightly so in an aqueous solution of iodide of potassium. When heated quickly, it fumes, and sublimes in red crystals, which become yellow by cooling. Solar light decomposes it, and changes its colour. Heated with potash or soda, it yields iodide of potassium and metallic mercury.

When recently prepared it is yellowish, and when heat is cautiously applied it sublimes in red crystals, which afterwards become yellow, and then by access of light they blacken. It is not soluble in chloride of sodium.—*Ph. Lond.*

COMPOSITION.—It consists of—

	Atoms.	*Eq. Wt.*	*Per Cent.*
Mercury	2	200	61·35
Iodine	1	126	38·65
Iodide of Mercury	1	326	100·00

PHYSIOLOGICAL EFFECTS.—It is a powerful irritant poison. A scruple killed a rabbit within twenty-four hours, and a drachm destroyed a pointer dog in five days.[1] In small but repeated doses, it appears to exercise a specific influence over the lymphatic and glandular system. Two grains taken daily caused salivation in two instances.[2]

USES.—It has been used in syphilis and scrofula, especially when they occur in the same individual. Lugol[3] employed an ointment of it in those forms of external scrofulous disease which resemble syphilis. Ricord[4] gave it internally with good effect in *syphilis infantum*. Biett[5] has successfully employed it in syphiltic ulceration and venereal eruptions. [He considered it to be one of the most valuable preparations of mercury in the treatment of syphilis.[6]—ED.]

ADMINISTRATION.—The dose of it for adults is from one grain gradually increased to three or four. Ricord gave from one-sixth to one-half of a grain to children of six months old. Biett employed it internally, and also externally, in the form of ointment, to the extent of twelve or fourteen grains daily, by way of friction.

1. UNGUENTUM HYDRARGYRI IODIDI, L.; *Ointment of Iodide of Mercury.* (Iodide of Mercury, ʒj.; White Wax, ʒij.; Lard, ʒvj. M.)—This is used as a dressing for scrofulous ulcers, or for syphilitic ulcers in scrofulous subjects. It is also employed in tubercular skin diseases,—as lupus, rosacea, and sycosis.[7]

---

[1] Cogswell, *Essay on Iodine and its Compounds*, p. 160.

[2] Biett, *Lancette Française*, Juin 1831.

[3] *Essays on the Effects of Iodine in Scrofulous Disorders*, by Dr. O'Shaughnessy, p. 170.

[4] *Lancette Française*, 1835, No. 65.

[5] O'Shaughnessy's *Trans. of Lugol's Essays*, p. 201.

[6] *Medical Times*, vol. xxi. p. 30.

[7] Rayer, *Treat. on Skin Diseases*.

2. Hydrarg

HISTORY.—This c
(*hydrargyri biniodi*
and *red* or *scarlet io*
NATURAL HISTORY
brown particles.
PREPARATION.—B
for the preparation
copœia.]

The *Edinburgh College*
of Muriate of Soda, *a G*
sionally a little rectified
to fine powder, and disso
ebullition. Filter, if ne
the crystals which form
The process of the *D*
Iodide of Potassium, ℥ij
the corrosive sublimate
when both solutions are
pitate has subsided, and,
remainder of the water.
and preserve it in a close

In the Edinburgh
or biniodide. The alc
iodine, and forming a
mon salt employed ser
(which is insoluble in
crystalline form. Co
large quantities of the
evolved when mercury
Per- or biniodide o
of perchloride of mer
adopted by the Dublin
sublimate are required
potassium. HgCl + K
In order to obtain
absence of perchloride
potassium should be em
cury in solution, but th
of potassium combines
double salt (HgI,KI).
pale-red precipitate (co
chloride) is obtained.
periodide in solution.
PROPERTIES.—Period
and crystalline form var
α. *Red Periodide of*
met with, periodide of

6·2 to 6·32. It is insoluble in water, but soluble in alcohol, some acids, alkalies, and solutions of iodide of potassium, chloride of sodium, and of many of the mercurial salts. When dissolved to saturation in a hot solution of either iodide of potassium or iodide of zinc, it is deposited, on cooling, in the form of square octohedrons. When heated, the red periodide becomes bright yellow, and then fuses, forming a deep ruby-red or amber-coloured liquid, which, by cooling, congeals into a yellow crystalline mass (*var.* β). This, by further cooling, or by mechanical disturbance, or by partial disintegration, suddenly assumes a scarlet colour: the change commencing, in the latter case, at the point ruptured.[1] If the heat be raised sufficiently, the fused periodide is volatilised, and sublimes in the form of yellow right rhombic prisms (*var.* β); but if the temperature be very slowly raised, and the sublimation be carefully conducted, red crystals, having the form of square octohedrons, are obtained.

[Mr. J. B. Barnes[2] finds, by experiment, that *cod liver oil* possesses the property of dissolving biniodide of mercury; and, as both are often administered at the same time, the medical practitioner may find it convenient, when these remedies are required to be given together, to dissolve the biniodide in the oil. Solution is readily effected at the ordinary temperature of the atmosphere, to the extent of half a grain to the fluidounce, by rubbing down the biniodide in a small portion of oil, mixing it with the remainder in a bottle, and shaking for a few moments; at the temperature of 120°, two grains are permanently dissolved by one fluidounce of oil. Mr. Barnes also finds that biniodide of mercury dissolves with the same facility in almond, olive, and castor oils, also in chloroform, pyroxilic spirit, and melted lard and spermaceti cerate.—ED.]

β. *Yellow Periodide of Mercury.*—This is obtained by heating the red periodide; by fusing and partially cooling the red periodide; by subliming the red periodide; and also by precipitation from a solution of a persalt of mercury by iodide of potassium: in the latter case the yellow crystalline grains soon dissolve, and at the same time crystals of the red periodide make their appearance. The citron-yellow crystals of periodide belong to the right prismatic system: they are not permanent, but readily pass into the red state.

Characteristics.—Heated with carbonate of soda or potash in a tube, it yields metallic mercury, which is volatilised: the residue is iodide of sodium and potassium, recognisable by the respective tests. From the subiodide of mercury it is distinguished by its colour and its solubility in a solution of chloride of sodium. The effects of heat on it, and its solubility in iodide of potassium, are other characters which serve to recognise it.

COMPOSITION.—Its composition is as follows:—

	Atoms.	*Eq. Wt.*	*Per Cent.*		*Vols.*
Mercury	1	100	44·25	Vapour of Mercury	1
Iodine	1	126	55·75	Vapour of Iodine	1
Biniodide of Mercury	1	226	100·00	Vapour of Iodide of Mercury	1

PURITY.—The presence of persulphuret of mercury in it may be recognised by fusion with caustic potash in a glass tube, by which a mixture of sulphuret

---

[1] Warington, *Memoirs of the Chemical Society*, vol. i. p. 85, 1843.

[2] *Pharmaceutical Journal*, Oct. 1853, p. 188.

and iodide of potassi
by the evolution of hy

"Entirely vaporisable
muriate of soda at 212°,

PHYSIOLOGICAL E
twenty-four hours: t
grains, dissolved in a
caused vomiting, pain
animal was well.[1] M
β. *On Man.*—It i
ful as the perchloride
than the latter. Ap
it cause excruciating
induces, says Rayer, a
to be administered int
pounds, its repeated u
USES.—It has been
as the subiodide of m
been employed by M.
it, in the form of oint
(thought to have been
of a dilute and thin
cerate, ℈ij.; and alm
In obstinate ophthalm
also been successfully
ADMINISTRATION.—
gradually increased to
form of pills, or dissol

1. UNGUENTUM HYD
of Mercury. (Red I
M.)—Used in the be
require to be considera

2. LIQUOR ARSENIC
Iodo-Arsenite of Mer
troduced into medical
the following directions

"Triturate 6·08 grains
50 grains of iodine, with
and from being deep brow
and after trituration for a
of hydriodic acid, prepare

---

[1] Cogswell, *Essay on Iodin*
[2] *Journ. de Chim. Méd.* iii
[3] *Treatise on Skin Diseases*
[4] *Bulletin Thérapeutique,*
[5] O'Shaughnessy's *Trans.*
[6] Gräfe and Walther's *Jour*
[7] *Dublin Medical Journal,*
p. 425, 1842.

few minutes. When the solution is cold, if there be any deficiency of the original eight ounces make it up exactly to that measure with distilled water. Finally, filter."

The *Dublin* formula is very similar to this. We subjoin it :—Take of Pure Arsenic, in fine powder, grs. vj.; Pure Mercury, grs. xvj.; Pure Iodine, grs. lss.; Alcohol, f℥ss.; Distilled Water, ℥ix., or a sufficient quantity. Rub together the arsenic, mercury, iodine, and spirit, until a dry mass is obtained, and, having triturated eight ounces of the water with this in successive portions, let the whole be transferred to a flask, and heated until it begins to boil. When cooled and filtered, let as much distilled water be added to it as will make the bulk of the solution exactly eight fluidounces and six drachms.

When the arsenic, mercury, and iodine, are triturated together with the alcohol, the iodine combines with the metals. The quantity of iodine is about sufficient to convert the arsenic into the teriodide (AsI^3), and the mercury into the periodide (HgI). We may therefore regard this solution as essentially consisting of these two iodides in solution or combination. Mr. Donovan considers that, by solution in water, these two become converted into hydriodates; but there is no evidence of this. Each fluidrachm of this solution contains a quantity of teriodide of arsenic equivalent to one-eighth of a grain of arsenious acid; and of per- or iodide of mercury, equivalent to a quarter of a grain of the peroxide of mercury. In addition, it also contains a minute portion of hydriodic acid, which Mr. Donovan estimates as equal to three-quarters of a grain of iodine.

"The colour of the solution is yellow, with a pale tinge of green; its taste is slightly styptic. It cannot be properly conjoined with the tincture of opium, or with sulphate, muriate, or acetate of morphia; for all these produce immediate and copious precipitates in it. Hence, if opiates are to be used during the exhibition of this arsenico-mercurial liquor, they must be taken at different periods of the day. Tincture of ginger produces no bad effect. The following formula is proper :—℞ Liq. Hydriodatis Arsenici et Hydrargyri, ʒij.; Aquæ Distillatæ, ℥iiiss.; Syrupi Zingiberis, ʒss. Misce. Divide in haustus quatuor. Sumatur unus mane nocteque." (Donovan.) Each of these draughts contains the equivalent of one-sixteenth of a grain of arsenious acid, and the equivalent of one-fourth of a grain of the peroxide of mercury. "The division into draughts is here necessary; first, to insure accuracy of the dose, so essential in the case of this active medicine; and, next, to prevent injury to the ingredients by the use of a metallic spoon as a measure, the general way in which, unfortunately, the dose of a medicine is determined" (Donovan).

On repeating this process, Soubeiran[1] found that a portion of arsenic remained undissolved; he has therefore proposed the following simple substitute for Donovan's formula :—Teriodide of arsenic, one part; periodide (biniodide) of mercury, one part; water, 98 parts. To make f℥viij. on this principle, take teriodide of arsenic, gr. xxxv.; periodide (biniodide) of mercury, gr. xxxv.; boiling distilled water, ℥viij. Triturate until dissolved, and then filter the solution; and, if necessary, add water to make exactly ℥viij. of solution.

Soubeiran's solution is somewhat stronger than Donovan's. The following table shews the comparative quantities of the active ingredients in the two solutions, reduced to French grammes :—

---

[1] *Journ. de Pharmacie*, t. xxvii. p. 744, 1841.

Arsenic ....
Mercury ....
Iodine ....

Soubeiran's solu
iodides. Both Do
arsenic and periodi
of these salts. It
been most successful
psoriasis, pityriasis,
cutaneous affections
diseases.[1] [For thi
macopœia.—Ed.]

The dose of it is
equal proportion of
in which it has been

182. HYDRA

History.—This s
pointed out by Gay-
lations, as *Prussia*
Hydrocyanate, Cy
gyri Prussias, Hy

Preparation.—T
mended by Proust, t
adopted in two of th

The *London College* f
Binoxide of Mercury,
and strain. Evaporate
frequently with boiling
may be formed. The *L*
of Mercury, *five parts ;*

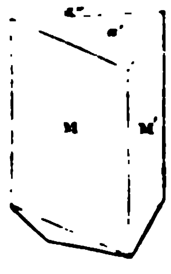
In this process t
mercury of the nitri
oxide. Pure percyar
Winckler's process.
oxide of mercury. T
In this process dou
being water and perc

Properties.—The
heavy, white, colourle
metallic taste. They
if at all so, in alcohol

---

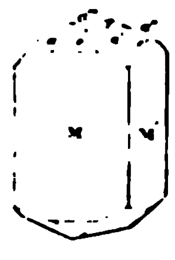
[1] See *L*

FIG. 146.



General Form of Crystals of Percyanide of Mercury.

FIG. 147.



Crystals with Modified Planes.

Characteristics.—Perfectly dry percyanide of mercury, when heated, yields metallic mercury and cyanogen gas. The latter is known by the violet or bluish red colour of its flame. Heated with hydrochloric acid, it evolves hydrocyanic acid. It is not decomposed by nitric acid or the alkalies. Its solution throws down a black precipitate with hydrosulphuric acid, and white pearly crystalline plates (*hydrargyro-iodo-cyanide of potassium*) with a concentrated solution of iodide of potassium.

[COMPOSITION.—Its composition is variously stated, according to the number assumed for the equivalent of mercury. The greater number of British chemists now consider it to be constituted of a single equivalent of each element, and therefore represented by the formula $HgCy$. The term Percyanide is given to it, in order to keep the nomenclature in conformity with that adopted by the author. There is no other cyanide of mercury known.—ED.]

PURITY.—When prepared from ferrosesquicyanide of iron (Prussian blue), the crystals are usually yellowish, from the presence of some oxide of iron. The following tests of its purity were published in the previous edition of the London Pharmacopœia:—

Transparent and totally soluble in water. The solution, when hydrochloric acid is added, emits hydrocyanic acid, which is known by its peculiar smell, and a glass moistened with a solution of nitrate of silver and placed over it, gives a deposit, which is dissolved by boiling nitric acid. By heat it emits cyanogen, and runs into globules of mercury.

PHYSIOLOGICAL EFFECTS. α. *On Vegetables*—It acts on plants like perchloride of mercury.[1]

β. *On Animals.*—Coulon[2] found that it acted on dogs, cats, sparrows, frogs, and snails, like hydrocyanic acid. After death, inflammation of the stomach was observed. Ollivier d'Angers[3] tried its effects on dogs. Seven grains dissolved in water killed a small dog in ten minutes, under attempts to vomit, general convulsions, and exhaustion, manifested alternately; respiration and circulation were at first accelerated, and afterwards diminished. Similar effects were produced by applying the salt to the cellular tissue, or injecting it into the veins. Tiedeman and Gmelin[4] detected mercury in the

---

[1] Goeppert, in De Candolle, *Phys. Vég.* 1836.

[2] *Traité sur l'Acide Prussique*, quoted by Wibmer, *Wirk. d. Arzneim.* iii. 30.

[3] *Journ. de Chim. Méd.* i. 269.

[4] *Versuche üb. d. Wege auf welch. Subst. aus d. Magen u. Darmk. ins Blut gelang.*

blood of the spleni
nistered.

γ. *On Man.*—
vomiting. Parent
perchloride of me
In one case, one-ei
Mendaga[3] says it s
very speedily allay

In *large doses,*
system, and causes
grains, in one inst
symptoms were—c
abundant ptyalism
but became succes
and not tender, not
semi-erection of t
scrotum; and ulti

Uses.—It has b
used as such by B
chloride of mercur
soluble, it ought to
tric pain; and, la
salts, and many s
sublimate, have no
solution or ointme

It has been empl
eases, in obstinate

Its principal use
cyanogen gas.

Administration
of a grain graduall
in the form of pills
will be frequently a
When used as a
of water. An *oint*
pound to an ounce

Antidote.—I ar
not decompose it.
the effect on the ne
cipal object must b
effected by the ston

---

[1] *Journn. de Chim. Méa*
[2] Neumann, in Dierbac
[3] *Decades Medico-chir*
[4] *Journ. de Chim. Méa*
[5] Richter, *op. cit.*
[6] *Journ. de Chim. Méd*

[183. Potassii et Hydrargyri Iodo-cyanidum.—Iodo-cyanide of Potassium and Mercury.]

Formula $HgCy,KI$. *Equivalent Weight* 291.

[The name of this compound has been introduced into the Appendix of the London Pharmacopœia as an article adapted for the purpose of testing the purity of hydrocyanic acid. It was first proposed by Dr. Geoghegan, of Dublin, as a test for determining the freedom of hydrocyanic acid from any foreign acid.

PREPARATION.—Dissolve in a minimum quantity of warm water equivalent weights of cyanide of mercury and iodide of potassium. If sufficiently saturated, colourless prismatic crystals will be deposited when the liquid has cooled.

PROPERTIES and USES.—The crystals are quite soluble in water, and the solution is decomposed by all acids excepting the hydrocyanic. If the hydrocyanic acid be free from any foreign acid the crystals simply dissolve in it without change of colour ($HgCy,KI+HCy$). If a hydracid, such as the hydrochloric, be present, the red iodide of mercury is immediately produced:—thus $HgCy,KI+HCl=HgI+KCl+HCy$, hydrocyanic acid and chloride of potassium being at the same time formed. If an oxacid be present, then water is decomposed, and we have the following changes, $HgCy,KI+SO^3HO=HgI+KO,SO^3+HCy$. Any vegetable acid which can combine with potash will produce the same effect. Even the carbonic acid of the atmosphere slowly produces this change on the crystals.

The presence of a foreign acid in hydrocyanic acid is therefore indicated by the production of a red colour on the addition of a few of these crystals at the end of a glass rod. It is undoubtedly a delicate test, but we are bound to state as the result of our own experiments that it is less delicate than the ordinary barytic test, so far as sulphuric acid is concerned: for in one sample nitrate of baryta produced a slight cloudy precipitate in which these crystals underwent no change of colour.—ED.]

184. HYDRARGYRI NITRATES.—NITRATES OF MERCURY.

Six solid compounds of nitric acid and the oxides of mercury are known: three are nitrates of the suboxide, and three nitrates of the oxide.

Nitrates of the Suboxide of Mercury	Bibasic Nitrate of the Suboxide of Mercury	$2Hg^2O,NO^5,HO$
	Sesquibasic Nitrate of the Suboxide (crystallised)	$3Hg^2O,2NO^5,3HO$
	Neutral Nitrate of the Suboxide (crystallised)	$Hg^2O,NO^5,2HO$
Nitrates of the Oxide of Mercury	Sexbasic Nitrate of the Oxide of Mercury	$6HgO,NO^5$
	Tribasic Nitrate of the Oxide	$3HgO,NO^5,HO$
	Bibasic Nitrate of the Oxide (crystallised)	$2HgO,NO^5,2HO$

In addition, there are possibly other mercurial nitrates obtained in solution, but they have not hitherto been procured in the solid state.

Of these compounds, it will be necessary to notice two only—namely, the neutral nitrate of the suboxide, and the bibasic nitrate of the oxide.

1. Hydrargyri Protonitras.—Neutral Nitrate of the Suboxide of Mercury.

Formula Hg^2O,NO^5. *Equivalent Weight* 262.

NATURAL HISTORY.—Glocker[1] mentions, on the authority of John, a doubtful mineral which he calls *hydrargyronitrites*, composed of suboxide of mercury and nitric acid.

PREPARATION.—Neutral nitrate of the suboxide of mercury is obtained by digesting

---

[1] *Genera et Species Mineralium secundum Ordines Naturales Digestorum Synopsis*, 1847, p. 302.

basic nitrate of the s
and suboxide of merc

PHYSIOLOGICAL EF
mediate between thos
becomes converted in
alimentary canal. Ac
chloride be present, a

USES.—Protonitrat
it undergoes decompo
its internal employme
cathæretic or mild ca
porrigo and in diseases
posed of 2 parts of pr
antiherpetic pommade c
one part of rose oil.
of from $\frac{1}{16}$th to $\frac{1}{8}$th of

In pharmacy the pr
calomelas præcipitatum
for the preparation of

LIQUOR HYDRARGYI
Liquor Hydrargyri Nit
of protonitrate of mer
scruples of nitric acid
so that the sp. gr. of
vessel. The dose of th

2. Hydrargyri

F

PREPARATION.—I
when diluted with
addition of a solutio
the oxide of mercur
it acquires the dens
and colours the ski

PROPERTIES.—If the crystallised bibasic nitrate be washed with cold water as long as the liquid runs off sour, a heavy yellow powder is obtained, which is the *tribasic nitrate of the oxide of mercury*, $3HgO,NO^5,HO$: this, when boiled in water, yields a brick-red powder, which is the *sexbasic nitrate of the oxide of mercury*, $6HgO,NO^5$.

PURITY.—The presence of nitrate of the suboxide of mercury in a solution of nitrate of the oxide of mercury is known by the production of a white precipitate (calomel) on the addition of a solution of common salt.

PHYSIOLOGICAL EFFECTS.—This nitrate is more acrid and caustic than the protonitrate. Its effects are analogous to those of corrosive sublimate. Indeed, it becomes converted, in the alimentary canal, into the latter salt by the action of the alkaline chlorides it there meets with.

USES.—Internally, it is now never employed. It was formerly given in doses of $\frac{1}{16}$th of a grain. Externally, it is used in two forms,—as an acid solution, and as an ointment.

1. **LIQUOR HYDRARGYRI PERNITRATIS**, D.; *Solution of Pernitrate of Mercury; Nitras Hydrargyricus Acido Nitrico Solutus; Liquid Acid Deutonitrate of Mercury; Acid Nitrate of Mercury.* (Take of Pure Mercury, ℥ij.; Pure Nitric Acid, f℥iss.; Distilled Water, ℥iss: in the acid, first diluted with the water, dissolve the mercury with the application of heat, and evaporate the solution to the bulk of ℥ijss. *D.*) (Take of Mercury, four parts, by weight; Nitric Acid [sp. gr. 1·32], eight parts, by weight: dissolve the mercury in the nitric acid, and evaporate the solution to nine parts.)—This solution is dense and very caustic. It contains 71 per cent. of pernitrate of mercury, and an excess of nitric acid. It is frequently employed in the Parisian hospitals as a caustic. Biett frequently employed it with success in lupus. It should be applied to the extent of a crown-piece, by means of a brush, to the ulcers, tubercles, and scars which remain soft or purple, and seem on the point of breaking: lint moistened with the solution is then to be applied to the cauterised surface. The parts immediately become white, a kind of erysipelatous inflammation is set up in the surrounding parts, and in a few days a yellow scab gradually falls off.

This solution is also used for the cauterisation of the ulcerated cervix uteri. "When the inflammation is intense, the ulceration large, and the granulations redundant or unhealthy, it exercises a very prompt and beneficial influence, generally cleansing and modifying the sore in one application. In very slight ulcerations, however, I think it is too powerful a remedy, and that the solid nitrate of silver answers the purpose better."[1]

It has been used by Recamier[2] as a caustic in cancerous diseases. He thinks it acts specifically, and modifies the vital actions of the surrounding parts. The acute pain which its application causes is alleviated by a strong solution of opium. Godard[3] employed it in herpes exedens. It has likewise been used with success in a great variety of other cases,—as syphilitic and scrofulous ulcers, condyloma, obstinate lepra and psoriasis, and porrigo favosa.

---

[1] *A Practical Treatise on Inflammation, Ulceration, and Induration of the Neck of the Uterus*, by J. H. Bennet, M.D. p. 147, 1845.

[2] *Rech. sur le Traitement du Cancer*, 1829.

[3] *De l'Emploi du Nitrate Acide de Mercure:* Thèse présentée et soutenue à la Faculté de Médecine de Paris, 1826. Also *Archives Générales de Médecine*, t. xi. pp. 204-207.

By the *local* use of this acid nitrate of mercury, the constitutional of mercury have been produced. Breschet has seen salivation induced application of it to the ulcerated neck of the uterus.[1] In such cases it pr passes into the system in the form of corrosive sublimate, into which converted by the alkaline chlorides contained in the secretions of the which it is applied. To prevent absorption, Mialhe recommends th cauterised part should be washed immediately after the application caustic.

2. UNGUENTUM HYDRARGYRI NITRATIS, L. D.; *Ointment of Nit Mercury; Yellow* or *Citrine Ointment* (*Unguentum Citrinum*, E *Mercurial Balsam* (*Balsamum Mercuriale*).—It is an imitation *golden eye-ointment.* All the British Colleges give directions for it paration.

The *London College* orders of Mercury, ℥ij.; Nitric Acid, f℥iv.; Lard, lb j.; O f℥viij. First dissolve the mercury in the acid; then mix the solution while hot lard and oil melted together.

The *Edinburgh College* directs of Pure Nitric Acid, sp. gr. 1·380 to 1·390, Mercury, ℥iv.; Axunge, ℥xv.; Olive Oil, f℥xxxviiiss. Dissolve the mercury in with the aid of a gentle heat. Melt the axunge in the oil with the aid of a heat in a vessel capable of holding six times the quantity; and while the mixtur add the solution of mercury, also hot, and mix them thoroughly. If the mixtur froth up, increase the heat a little till this takes place. Keep this ointment in eart vessels, or in glass vessels secluded from the light.[2]

The *Dublin College* orders of Pure Mercury, ℥j.; Pure Nitric Acid, f℥j.; Water, ℥ss.; Prepared Lard, ℥iv.; Olive Oil, f℥viij. Mix the acid with the wa dissolve the mercury in the mixture, with the aid of a gentle heat. Melt the l the oil, and, while the mixture is hot, add to it the solution of mercury, also hot; temperature of the mixture next be raised so as to cause effervescence, and, the drawing the heat, stir the mixture with a porcelain spoon until it concretes on co

By the action of concentrated nitric acid on mercury, nitrate of th of mercury is produced ($3Hg + 4NO^5 = 3(HgO,NO^5) + NO^2$). The L and especially the Edinburgh College, use an excess of nitric acid. Wh solution is mixed with the lard and olive oil, a portion of elaïdine[3] is pro as well as a red viscid oil. Soubeiran[4] says that carbonic acid and bi of nitrogen gases are evolved, but Mr. Schacht[5] could not detect He obtained only the vapour of nitric acid, having the peculiar smell ointment.

By keeping, this ointment is apt to change its colour, and become pulverisable, and therefore unfit for use. The nitrate of the oxide of m undergoes deoxidation, and is ultimately reduced to metallic mercury. grey colour which the ointment acquires by keeping is due to the dissemi of minute globules of metallic mercury through the mass. If old ointment be digested in ether, the fatty matters are dissolved, and metallic mercury left behind. The cause of this change appears to be the use of an insufficient quantity of nitric acid and of too low a temperature. Mr. Duncan, of Edinburgh, first showed, that "by dissolving the metal in an excess of acid with the aid of heat,—using an additional quantity of acid for oxygenating all the fat, and applying a moderate heat at the time of mixing the fat and the metallic solution, so as to ensure complete action between them,—an ointment is obtained not inferior to the quack nostrum [*golden eye-ointment*] in original colour or durability."[1] The present formula of the Edinburgh College (as now corrected) is that of Mr. Duncan. MM. Henry and Guibourt[2] also direct a considerable excess of acid to be employed.

---

[1] Trousseau and Pidoux, quoted by Mialhe, in his *Traité de l'Art de Formuler*, p. 84 [A case is related by Dr. Lafargue, of Toulouse, in which the acid nitrate of mercury, us caustic to the os uteri, produced salivation. See *Lancet*, 1849, ii. 669.—Ed.]

[2] There is an error in the Edinburgh Pharmacopœia in the proportion of olive oil and density of nitric acid (see Christison's *Dispensatory*, 2d edit. p. 531). In the text I have co this error.—J. P.

[3] So called by Boudet (*Journ. de Chim. Méd.* viii. 641) from ἐμαῖς, ἐλαῖδος, *an olive tree.* ascribes the formation of the elaidine to the action of nitrous or hyponitrous acid.

[4] *Nouv. Traité de Pharmacie*, t. ii. p. 256.

[5] *Pharmaceutical Journal*, vol. iv. p. 451, 1845.

The following are several formulæ for its preparation :—

	United States Dispensatory.	*Paris Codex.*	*Henry and Guibourt.*	*Duncan.*	*Bell and Co.*[3]
				(Avoirdupois Weights).	
Mercury	℥j.	32 parts.	30 parts.	℥iv.	℥viij.
Nitric Acid	fʒxj. (sp. gr. 1·5).	48 parts (sp. gr. 1·286).	60 parts (sp. gr. 1·321).	℥xij.	f℥xiv. (sp. gr. 1·43).
Lard	℥iij.	250 parts.	240 parts.	(Nitrous Acid sp. gr. 1·380 to 1·390) ℥xv.	lb. iij.
Olive Oil	0	250 parts.	240 parts.	℥xxxij.	lb. ij.
Neat's-foot Oil...	f℥ix.	0	0	0	0

The two most important points to attend to in the manufacture of this ointment are—the due regulation of the heat, and the employment of a proper quantity of acid.

"If the mixture be made at a low temperature, no effervescence takes place, and the ointment so produced will become hard in a few days, of a greenish-white colour, and eventually of a consistence that may almost be powdered; but if the oil or fat is heated to a sufficient temperature, or the quantity operated on is large enough to generate the heat required, strong effervescence takes place, much gas is evolved, and a perfect article is produced, of a fine golden colour, and of the consistence of butter" (Alsop). The great success which attends the manufacture of large than of small quantities of this ointment, may be referred to the higher temperature generated by the reaction of larger quantities of the materials. Mr. Alsop says that the proper temperature is between 180° and 212°. A temperature of 190° F. yielded a fine product.

The importance of a sufficient quantity of acid has been already pointed out. Mr. Schacht has shown that ointment spoiled by age or accident, and which has become hard, discoloured, pulverulent, or even blackened, may be restored to its original beauty by heating it with nitric acid; and he has further shown that the use of an excess of nitric acid in the manufacture of the ointment is no disadvantage, for, if the heat be continued long enough, it distils off. Stirring assists the evolution of gas, and is usually believed to

---

[1] Christison's *Dispensatory*. Mr. Duncan's process was communicated to the late Dr. Duncan (*Supplement to the Edinburgh Dispensatory*, p. 196, 1829).

[2] *Pharmacopée Raisonnée*, p. 448, 3me édit.

[3] Alsop, *Pharmaceutical Transactions*, No. iii. p. 162, 1841.

favour the formation of a fine product; but Mr. Alsop asserts that a l
continued stirring is not required.

When fresh prepared, this ointment has a fine golden yellow colou
butyraceous consistence, and a peculiar nitrous odour. It is very ap
become grey when mixed with other ointments, in consequence of t
deoxidising powers; and to prevent this, an additional quantity of nitric
should be added. It should be spread with wooden or ivory spatulas.

When fresh prepared, this compound contains the following substan
besides the ordinary constituents of lard and olive oil:—elaïdine, red
elaïdate of mercury (mercurial soap), and nitrate of mercury.

Elaïdine is a white saponifiable fat, fusible at 97° F. [89·6 F. according to Me
very soluble in ether, but requiring 200 times its weight of boiling alcohol to disso
It consists of elaïdic acid and glycerin.

It is an irritant and slight caustic. When it has undergone decomposi
by keeping, it irritates ulcers exceedingly, and even excites slight erysipela
inflammation.

We employ it as a stimulant and alterative in *chronic diseases of the s*
more particularly those affecting the hairy scalp, as the different form
porrigo, in which it is exceedingly efficacious. It is also used as a *dres*
to ulcers—to stimulate and cleanse them—as in foul syphilitic sores
phagedenic ulcers. Lastly, it is employed in *ophthalmic diseases*—
particularly ophthalmia tarsi, or psorophthalmia, in which it is applied (m
with its own weight of almond oil) by means of a camel's-hair pencil to
lids, frequently with such advantage, that some have regarded it as a spe
in this complaint.

2. **UNGUENTUM HYDRARGYRI NITRATIS MITIUS, L.** (Of Ointmen
Nitrate of Mercury, ℥j.; Lard, ℥vij. Rub them together.)—This ointme
is the one usually prepared.

[illegible] HYDRARGYRI ACETAS.—ACETATE OF MERCU

Formula $Hg^2O,\bar{A}$. *Equivalent Weight* 259.

HISTORY.—This compound was known to Lebefure in the 17th centur
PREPARATION.—The British pharmacopœias contain no directions for
[illegible] The following is the pharmaceutical process by which it
[illegible] prepared:—

[illegible] Mercury, Acetate of Potash, of each, nine parts; Diluted Nitric
[illegible] Distilled Water, one hundred parts; Distilled Vinegar, as mu
[illegible] let the Nitric Acid be added to the mercury, and when the effe
[illegible] let the mixture be digested that the metal may be dissolved: le
[illegible] be dissolved in water, and let the distilled vinegar be added unti
[illegible] in the liquor; to this, whilst boiling, let the solution of merc
[illegible] and let the mixture be filtered as quickly as possible thro
[illegible] set aside that crystals may form: having washed these with
[illegible] paper with a very gentle heat. In every step of this pr
[illegible]

[illegible] of diluted nitric acid and mercury we obtain a p

---

[1] [illegible] Central-Blatt für 1840, S. 790.

nitrate of mercury. When this is mixed with acetate of potash, double decomposition takes place: nitrate of potash and protoacetate of mercury being formed ($Hg^2O,NO^5+KO,\bar{A}=Hg^2O,\bar{A}+KO,NO^5$). To prevent precipitation of the yellow subnitrate of mercury, excess of acetic acid should be employed; and by filtering, whilst hot, any subnitrate which may be formed would be separated before the acetate has deposited.

PROPERTIES.—This salt occurs in white, micaceous, flexible scales, which are inodorous, but have an acrid taste. It blackens by light. When heated, it is resolved into carbonic acid, acetic acid, and mercury. It is very slightly soluble in water, requires 300 times its own weight of this liquid to dissolve it, according to Dumas. It is insoluble in cold alcohol: boiling alcohol abstracts part of its acid.

Characteristics.—Its appearance, its slight solubility in water, and the action of heat on it, are some of its characteristics. Heated with sulphuric acid, the vapour of acetic acid is evolved. The fixed alkalies precipitate the black oxide of mercury. Chloride of sodium forms calomel with it.

COMPOSITION.—It has the following composition:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Dumas.*
Suboxide of Mercury	1	208	80·3	80·66
Acetic Acid	1	51	19·7	19·34
Acetate of Mercury	1	259	100·0	100·00

PHYSIOLOGICAL EFFECTS.—It is one of the milder mercurial preparations. From the reports of Guarin, Colombier, and Vogler,[1] it appears to have acted in some cases with great violence, and to have occasioned violent vomiting, purging, abdominal pain, and bloody evacuations. These effects probably arose from the presence of some acetate of the binoxide of mercury.

USES.—It was introduced into practice in consequence of being supposed to be the active ingredient of Keyser's anti-venereal pills. But Robiquet has subsequently ascertained that Keyser employed the acetate of the binoxide.[2] It is occasionally used in syphilitic affections.

ADMINISTRATION.—The dose of it is from one to five grains. A solution, composed of one grain of the acetate dissolved in an ounce of water, may be used as a *wash*. An *ointment* is prepared by dissolving two or three scruples in an ounce of olive oil.

ORDER XXX. SILVER AND ITS COMPOUNDS.

186. ARGENTUM.—SILVER.

Symbol Ag. *Equivalent Weight* 108.

HISTORY.—Silver, like gold, has been known from the most remote periods of antiquity, being mentioned in the earliest books of the Old Testament.[3] It was termed by the alchemists and astrologers *Diana* or *Luna* ☽.

---

[1] Wibmer, *Wirkung d. Arzneim.* iii. 647.

[2] Dumas, *Traité de Chim.* v. 178.

[3] *Genesis*, xliv. 2; *Job*, xxii. 25.

and the disengaged silve
and the solution submitt
and the silver left behind
is somewhat different.[2]

Silver is obtained fron
roasted to expel the sul
argentiferous lead is ther
ing oxidised, is partly vol
leaving the silver.[3]

[Some years since, Mr
from lead without resortii
cupellation. A large qu
state, and allowed to cool
in masses of minute octo
rated from the more liqu
perforated. The greater
rendered serviceable for a
depends on the fact that
alloy of silver and lead is

English lead contains a
ounces in the ton. The s
ing for commercial purpos
containing only two ounc
the separation of the silve
improved in quality. The
process goes on until the
hundred ounces in the ton
seven dwts. The lead is t
pure. By an estimate no
lead raised in England an
been procured by the abov

ARGENTUM PURIFICATU
by immersing a piece of co

PROPERTIES.—In the native state, silver occurs crystallised in the cube and regular octohedron. When pure, this metal is white, with a slight shade of yellow; inodorous and tasteless. It is moderately hard and elastic; very ductile and malleable: a single grain may by drawn out into 400 feet of wire, and leaf silver (*argentum in laminas extensum; argentum foliatum*) may be procured, whose thickness is only $\frac{1}{100000}$th of an inch.[1] Its specific gravity is 10·474. It melts at a bright red heat (1873° F., according to Daniell). When exposed to the air it does not oxidate, but readily tarnishes by sulphur vapours.[2]

Characteristics.—It is soluble in nitric acid. (See *Nitrate of Silver.*)

PURITY.—The silver of the shops usually contains traces of gold and copper. The gold is left as a dark-coloured powder when the silver is dissolved in nitric acid.

Soluble entirely in diluted nitric acid: this solution, treated with an excess of muriate of soda, gives a white precipitate entirely soluble in aqua ammoniæ, and a fluid which is not affected by sulphuretted hydrogen.—*Ph. Ed.*

PHYSIOLOGICAL EFFECTS.—Silver in the metallic state is totally inert. It may remain for many months in the alimentary canal without exciting any ill effects.[3] Colic, however, has been ascribed to the handling of it.[4]

USES.—In pharmacy it is used for the preparation of nitrate, which is employed as a medicine and as a test.

Silver leaf is used for filling the hollows of decayed teeth, and is sometimes employed to cover pills. An *amalgam of silver* is also used by some dentists for stopping teeth. It is objectionable, on account of its becoming black by the formation of sulphuret of silver.

187. ARGENTI OXYDUM.—OXIDE OF SILVER.

Formula AgO. *Equivalent Weight* 116.

HISTORY.—The compound was a constituent of the *bezoardicum lunare* of Angelus Sala,[5] and which was lauded in diseases of the brain and uterus. Van Mons[6] and Serre[7] used it in syphilis. More recently, it has been again brought into notice by Dr. Butler Lane.[8] It is sometimes called *protoxide of silver* (*argenti protoxydum*), or *argentum oxydum fuscum*.

---

[1] [The lamination of silver has recently been carried to the 1-200,000th of an inch, and less. The lamination is now such that the leaf of pure silver is as transparent as that of gold. The colour seen by light transmitted through silver leaf is a reddish violet, the complementary tint of that which is reflected from silver (yellow white).—ED.]

[2] [*Argentum; Pure Silver.*—This is enumerated among the tests in the *Appendix to the London Pharmacopœia.* Pulverulent metallic silver, as it is obtained by precipitating a solution of the nitrate with copper, was proposed by the late Dr. A. Frampton as a test for corrosive sublimate. When shaken with any liquid containing corrosive sublimate, some chloride of silver appears to be formed, and a heavy amalgam of silver and mercury is precipitated. This amalgam may be obtained quite pure by washing it in distilled water; and then, on applying heat to it in a glass lute, mercury is sublimed in globules. It forms a convenient process for separating mercury in certain cases.—ED.]

[3] *Lond. Med. Gaz.* May 20, 1837.

[4] *Journ. de Chim. Méd.* t. vi. 2de Série, 1840.

[5] Gmelin, *App. Medicaminum*, vol. i. p. 362, 1795.

[6] Riecke, *Die neuern Arzneimittel.* 2te Aufl. 1840.

[7] *Mém. sur l'emploi des préparations d'argent dans le traitement des maladies vénériennes*, 1836.

[8] *Medico-Chirurgical Review*, July 1840; *Lancet*, July 10, 1841; *Lond. Med. Gaz.* April 10 and May 1, 1846.

It should be added that
solution of the nitrate o
repeatedly washed with
a temperature of about
the last edition of the I

Take of Nitrate of Silv
tilled Water, Oss. Dissolv
and, having poured the solu
well, and then set it by till
off, let the sediment be plac
distilled water, let it be drie

Ammonia must not b
facility with which an ex
the formation of fulmina
attended its manufacture
that when the oxide thus
bustion is apt to ensue.
the oxide may be mixed
Oxide of silver may be
chloride of silver with a
PROPERTIES.—Oxide o
so. By a dull red heat,
oxygen gas and metallic
soluble in caustic ammo
solution has an alkaline
by a small quantity of ca
COMPOSITION.—Oxide

	At
Silver	
Oxygen....................	
Protoxide of Silver ...	

it forms in the alimentary canal a combination, which, being soluble, is absorbed. After its absorption, it produces remote or constitutional effects, analogous to, but milder than, those of the nitrate. It has been described as possessing sedative ("organic sedative") and indirect tonic properties. Occasionally, it has excited salivation. Like the nitrate, and probably all other preparations of silver, its continued use is apt to be followed by discoloration of the skin.[1] But, probably because it less readily forms a soluble combination in the alimentary canal, it is somewhat less apt to discolour the skin; and, for the like reason, is less powerful in its action on the system, and less influential in the treatment of diseases than the nitrate of silver.

USES.—Its uses are analogous to those of the nitrate. It is well adapted for painful (neuralgic) and irritable conditions of the stomach and intestines, especially those which are attended with augmented secretions. Thus in gastrodynia and enterodynia, in pyrosis and chronic diarrhœa, it has proved serviceable. In uterine diseases, especially where there are augmented discharges and great irritability, it has been beneficial, as in hysteralgia, menorrhagia, leucorrhœa, and dysmenorrhœa. It has been used in epilepsy and syphilis, and also in the treatment of cholera by Dr. Brooks of Cheltenham.[2] Externally, it has been employed in the form both of powder and ointment; in irritable ulcers, both syphilitic and non-syphilitic, in ophthalmia, in sore nipples, and in gonorrhœa. In the latter complaint, it was used in the form of ointment applied to the urethral membrane by means of a bougie.

ADMINISTRATION.—The dose of it is from gr. ss. to gr. ij. twice or thrice daily, in the form of powder or pill. It may be continued for five or six weeks with safety; but its prolonged employment is liable to be attended with permanent discolouration of the skin. For external use, it may be applied in the form of ointment composed of ʒj. of oxide to ℥j. of lard.

188. Argenti Chloridum.—Chloride of Silver.

Formula AgCy. *Equivalent Weight* 143·5.

Muriate of Silver (*Argenti Murias*); *Horn Silver* (*Luna Cornea*).—This compound is found native. It may be obtained by adding an excess either of hydrochloric acid, or a solution of common salt, to a solution of nitrate of silver. $AgO,NO^5 + HCl = AgCl + HO,NO^5$. The white precipitate should be washed, collected on a filter, and dried at a gentle heat in the dark. (The chemical properties of chloride of silver have been before alluded to, see *ante*, p. 381). It was formerly used in medicine by Poterius, Tackenius, and Ferd. Hoffman,[3] but fell into disuse. More recently, its medicinal employment has been recommended by Dr. Perry,[4] an American physician, in epilepsy, chronic dysentery, and chronic diarrhœa.—Dose, three grains four or five times daily. Thirty grains at one dose caused vomiting. Twelve grains administered daily for three months produced no unpleasant symptoms.

---

[1] Dr. B. Lane, *Lond. Med. Gaz.* April 10, 1846; Dr. Christison, *Dispensatory*, 2d edit.

[2] *Medical Gazette*, vol. xliv. p. 338.

[3] *Operum Supplementum*, Pharm. Spagyr. cap. xv. p. 270, ed. 2nda, 1754.

[4] Dunglison, *New Remedies*.

189. ARGENTI CYANIDUM.—

Formula AgCy. *Equival*

History.—This compound, sometimes
or *Cyanodide of Silver,* or *Argentum*
Scheele, Ittner, and Gay-Lussac.

Preparation.—In the London Pharma
be prepared as follows :—

Take of Nitrate of Silver, ℥ij. and ʒiij.; Dilu
each Oj. Dissolve the nitrate of silver in the
Hydrocyanic Acid, and mix. Wash what is preci

In this process one equivalent or 27
one equivalent or 170 parts of nitrate
equivalent or 134 parts of cyanide of silv
of water, and setting free one equivalent or

Properties.—When thrown first down
drying becomes pulverulent. It is insipid
in caustic ammonia. It is decomposed b
acids, both of which develope with it hyd
other metallic cyanides to form the *argen*
atmosphere and solar rays it slowly assumes
posed by mixture with neutral vegetable su

Characteristics.—It is insoluble in co
boiling acid. When carefully dried and
yields cyanogen gas (which is readily kn
bluish-red colour of its flame) and a residu
is recognised by the before-mentioned tests

Composition.—The following is the com

	Atoms.
Silver	1
Cyanogen	1
Cyanide of Silver	1

Physiological Effects and Uses.—I
ments made to determine its effects on m
pellier,[2] gave it in syphilitic maladies, in
eighth of a grain, without the least incon
the London Pharmacopœia, at the sugges
hydrocyanic acid, but it has been excluded

---

[1] *Journ. de Chim. Méd.* 2e

[2] *Medico-Chirurgical Review*

190. ARGENTI NITRAS.—NITRATE OF SILVER.

Formula AgO,NO^5. *Equivalent Weight* 170.

HISTORY.—Geber[1] describes the method of preparing crystallised nitrate of silver. When this salt is fused, it is termed *lunar caustic* (*causticum lunare*). The term *infernal stone* (*lapis infernalis*) is sometimes applied to this salt, as well as to the hydrate of potash. Nitrate of silver is sometimes called *argentum nitratum*.

PREPARATION.—The Edinburgh and Dublin Colleges give directions for the preparation of this salt.

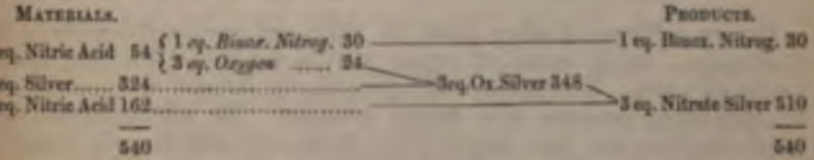
The *London College* gives no formula, but places this compound in the Materia Medica under the name of *Argenti Nitras Fusa*.

The directions of the *Edinburgh College* are as follows:—Pure Silver, ℥iss.; Pure Nitric Acid, f℥j.; Distilled Water, f℥ij. Mix the acid and water: add the silver, and dissolve with the aid of a gentle heat. Increase the heat gradually until a dry salt is obtained. Fuse the salt in an earthenware or porcelain crucible, and pour the fused matter into iron moulds previously heated and greased slightly with tallow. Preserve the product in glass vessels.

The *Dublin College* gives the following directions:—Take of Refined Silver, ℥iij.; Pure Nitric Acid, f℥ij.; Distilled Water, ℥v. Place the silver in a flask, and, having poured upon it the acid and water, apply a gentle heat until the metal is dissolved. Transfer the solution to a porcelain capsule, decanting it off a heavy black powder which appears at the bottom of the flask, and, having evaporated it to dryness, raise the heat (in a dark room) until liquefaction is produced. Pour the melted nitrate of silver into a brass mould furnished with cylindric cavities of the size of a goose-quill, and which admits of being opened by a hinge, and, when the salt has concreted, remove it, and preserve it in well-stopped bottles rendered impervious to light.

The fusion may be more readily and safely effected in a Berlin porcelain capsule over a spirit or gas lamp, by means of Griffin's lamp furnace, than in a crucible over a slow fire. Care must be taken not to overheat, and thereby to decompose the salt. The moulds should be warmed. It is unnecessary and objectionable to grease the moulds, as directed by the Edinburgh College.

Three equivalents of silver abstract three equivalents of oxygen from one equivalent of nitric acid, thereby disengaging one equivalent of binoxide of nitrogen, and forming three equivalents of oxide of silver, which unite with three equivalents of nitric acid to form three equivalents of nitrate of silver. $3Ag + 4NO^5 = 3(AgO,NO^5) + NO^2$.



PROPERTIES.—Nitrate of silver forms transparent, colourless, right rhombic prismatic crystals (*argenti nitratis crystalli*, Ph. L. Appendix). Its taste is strongly metallic and bitter. When heated, it fuses into a grey mass; if the temperature be increased, decomposition ensues, the nitric acid and oxygen

---

[1] *Invention of Verity*, ch. xxi.

from the action of
the atmosphere. M
glass tube, hermetical
to solar light: the co
become black. A sol
exposure to solar light
to become black or re
Characteristics.—
heated on charcoal, a
other characters befor
salt of silver are as
cipitate (AgCl), the pr
with solutions of the
precipitates (*carbonat*
tion of phosphate of
the alkaline arsenites,
a brick-red precipitate
lies, olive brown (Ag
crystals of metallic sil
sulphuric acid occasion
COMPOSITION.—Nit

Oxide of Silver ....
Nitric Acid ....

Nitrate of Sil

PURITY.—Nitrate of
tilled water. By the a
partial reduction. The
the blue colour produc
which the silver has b
unchanged by the add
lead and copper, and b

the nitrate of potash. "Pure fused nitrate of silver, ignited by the blowpipe in a small cavity of a piece of dense charcoal, leaves about 63 per cent. of pure silver" (Brande). The white precipitate produced with either hydrochloric acid or chloride of sodium should be readily dissolved by caustic ammonia: if chloride of lead be present, the effect will be otherwise.

White, soluble in water. This solution, copper being immersed in it, precipitates silver. If after seventeen grains of nitrate of silver have been added to six grains of chloride of sodium dissolved in water, more of the nitrate be added to the filtered liquor, nothing further is precipitated. The access of light to this substance must be prevented.—*Ph. Lond.*

[The fused nitrate is the compound introduced into the Materia Medica of the London Pharmacopœia. The *crystals* are noticed in the Appendix as serviceable for determining the purity of medicines.—ED.]

Soluble in distilled water, with the exception of a very scanty black powder: twenty-nine grains dissolved in one fluidounce of distilled water, acidulated with nitric acid, precipitated with a solution of nine grains of muriate of ammonia, briskly agitated for a few seconds, and then allowed to rest a little, will yield a clear supernatant fluid, which still precipitates with more of the test.—*Ph. Ed.*

PHYSIOLOGICAL EFFECTS. α. *On Animals.*—Orfila[1] found that it acted on animals as a powerfully corrosive poison. When dogs were made to swallow it, gastro-enteritis was induced. No symptoms indicating its absorption were observed. Dissolved in water, and thrown into the jugular vein, it produced difficult respiration, convulsive movements, and speedy death.

β. *On Man.*—The *local action* of nitrate of silver is that of a caustic or corrosive. This might be expected, from observing its action on albumen and fibrin,—substances which form the principal part of the animal textures. If a solution of nitrate of silver be added to an albuminous liquid, a white curdy precipitate is formed, composed[2] of *albumen* 84·5, and *nitrate of silver* 15·5. This precipitate is soluble in caustic ammonia, and in solutions of nitrate of silver, albumen, and chloride of sodium. After some time it becomes coloured, and ultimately blackish, from the partial or complete reduction of the silver. The action of nitrate of silver on milk,[3] as well as on fibrin, is analogous to that on albumen; that is, a white compound of nitrate of silver and of these organic substances is at first formed, but gradually the metal is reduced. These facts assist us in comprehending the nature of the changes produced by the application of nitrate of silver to the different tissues.[4]

Applied to the skin, it produces first a white mark, owing to its union with the coagulated albumen of the cuticle: gradually this becomes bluish-grey, purple, and ultimately black, owing to the partial reduction of the silver. If the integument be moistened, and the nitrate applied three or four times, it causes, at the end of some hours, vesication, which is usually attended with less pain than that produced by cantharides. In some cases it excites acute pain. In one instance in which I applied it freely to the scalp for a cutaneous affection, fever with delirium was produced, which endangered the life of the patient (a girl of six years). This is deserving of notice, because, in Mr. Higginbottom's work,[5] we are told that nitrate of silver applied as a

---

[1] *Toxicol. Gén.*

[2] Lassaigne, *Journ. de Chim. Méd.* t. vi. 2e Série, p. 306.

[3] Dr. C. G. Mitscherlich, *Pharmaceutisches Central-Blatt für* 1839, S. 417.

[4] See some remarks of Mulder on the action of metallic salts on fibrin and albumen, in the *Pharmaceutisches Central-Blatt für* 1838, S. 513.

[5] *Essay on the Use of the Nitrate of Silver*, 2d edit. p. 198.

vesicant "causes scarcely any constitutional irritation, even in c
In a few days the black and destroyed cuticle cracks and falls off, wi
destruction of the subjacent cutis vera. [Mr. Higginbottom,[1] aft
years' further experience since the publication of the observations ref
the text, repeats his assertion, that "nitrate of silver is not a causti
sense of the word." "It subdues," he adds, "inflammation, an
resolution and the healing process. It preserves and does not de
part to which it is applied." The action of a caustic, as potassa
same writer urges, is to destroy, produce a slough and the ulcerativ
whereas the eschar which falls off after the application of nitrate of si
the parts beneath healed.—ED.]

Applied to the hair or nails, the nitrate stains them black, as in t
the cuticle; and, in consequence, it is one of the substances empl
hair dye. When recently applied, the black tint of the hair, and ev
cuticle, may be removed by washing with a solution of chloride of so
then with ammonia-water, to dissolve the chloride of silver which is p
[or, in stains of long standing, by wetting them with the iodide, and sub
with the cyanide of potassium.—ED.] To detect silver in stained
latter is to be treated with chlorine or iodine, by which chloride or
silver is produced, which is soluble in ammonia and in hyposulphite
It is precipitable from its solution in ammonia by nitric acid.[3] P
black colour of the hair stained by the nitrate depends on the form
sulphuret of silver.

When nitrate of silver is applied to an ulcer, it produces a white fil
to its union with the albumen, and perhaps also with the chloride
secretion). This film in a few hours assumes a dark colour, and u
forms a black eschar. This hardens, and in a few days becomes co
separates at the edges, and at length peels off altogether, leaving th
of the sore beneath in a healed state.[4] The intensity of the pain var
in different cases; but it is, on the whole, very much less than might
gined by those who have not tried this remedy.

When applied to mucous membranes, a similar white compound of th
with the animal matter of the secreted mucus is formed, and this def
living tissue from the action of the caustic, so that the effects are not s
as might be expected. Thus the solid nitrate may be applied to the
surface of the vagina, and even to the os uteri, in cases of leucorrh
gonorrhœa, oftentimes without exciting any pain or inflammation: i
instances, however, it produces smarting pain, which lasts for severa
but no serious effects have resulted from its use, even when, by accide
drachms of nitrate have been left to dissolve in the vagina.[5]

Its chemical effects on the other mucous membranes are analogous t
just mentioned, but the pain which it produces varies with different mem
and in the same membrane under different states. Its application to t
junctiva is attended with acute pain (especially when inflammation is go

---

[1] *Lancet*, 1850, vol. i. p. 74.

[2] *Journ. de Chimie Méd.* vii. 542.

[3] Devergie, *Méd. Lég.* ii. 933; Herapath, *Pharm. Journ.* vol. vi. p. 476.

[4] Higginbottom, *op. cit.* p. 10.

[5] Dr. Hannay, *Lond. Med. Gaz.* xx. 185; also Mr. Bell, *ibid.* 478; and Dr. Jew
Observ. on Leucorrhœa.

though in general this soon subsides. On all these surfaces it acts as an astringent.

The safety with which, in most cases, large doses of the nitrate are administered internally, must depend on the presence of the mucus which lines the internal coat of the stomach, and on the chlorides and free hydrochloric acid contained in this viscus. These form with the nitrate new compounds (*albuminate* and *chloride*), less energetic in their local action than the nitrate. It is deserving of especial notice that larger doses may be exhibited, without inconveniencing the stomach, in the form of pill than in that of solution,—in consequence, I presume, of the latter acting on a larger surface. Dr. Powell[1] in some cases was enabled to give fifteen grains at a dose in the form of pills, while he rarely found stomachs that could bear more than five grains in solution. Fouquier[2] has also remarked the greater activity of the solution. If cautiously exhibited, beginning with small doses and gradually increasing them, it may be employed for a considerable period without producing any obvious changes in the corporeal functions, although it may be exercising a beneficial influence over the constitution, evinced by its amelioration of certain diseases, as epilepsy. In some cases it has caused an eruption.[3] If the dose be too large, it occasions gastrodynia, sometimes nausea and vomiting, and occasionally purging. Taken in an excessive dose, it acts as a corrosive poison, but cases of this kind are very rarely met with. Boerhaave mentions an instance in which it caused excruciating pain, gangrene, and sphacelus of the first passages.

All the above-mentioned effects are referable to its local action, and from them we have no evidence of its absorption, or of the nature of its influence over the general system. But the discoloration of the skin, presently to be noticed, fully proves that absorption does take place when the medicine is exhibited in small but long-continued doses. It exercises a specific influence over the nervous system; at least I infer this, partly from the effects observed by Orfila when it was injected into the veins of animals, and partly from its occasional curative powers in affections of this system, as epilepsy and chorea.

The blueness, or slate colour, or bronze hue of the skin just alluded to, has been produced in several patients who have continued the use of the nitrate during some months or years.[4] In some of the cases the patients have been cured of the epilepsy for which they took the medicine; in others the remedy has failed.[5] In one instance which fell under my notice, no perceptible diminution of the colour had occurred for several years; but in some cases it fades in intensity. The corion is the essential seat of it. Dr. Baddeley[6] found that blisters rose white,—a proof that in his patient the colouring matter was below the epidermis. But in some instances the cuticle and corpus mucosum of the face and hands participate in the tint. In one instance the mucous membrane of the stomach and intestines was similarly tinted. A case is mentioned by Wedemeyer[7] of an epileptic who was cured by nitrate of silver, but eventually

---

[1] *Med. Trans. of the College of Physicians*, iv. 85.

[2] *Dict. Mat. Med.* i. 403.

[3] Sementini, *Quart. Journ. of Science*, xii. 189; Copland, *Dict. Pract. Med.* i. 68.

[4] *Med.-Chir. Trans.* vii. and ix.

[5] Rayer, *Treatise on Skin Diseases*, by Willis, 961.

[6] *Med.-Chir. Trans.* ix. 238.

[7] *Lond. Med. Gaz.* iii. 650.

of silver, will be disp
the compounds of cl
chloride or the black

Uses.—Nitrate of
only; and of these th
angina pectoris Its
its use: a medical m
without previously in
ascribes its good effec
in a large number of
mere assumption, per

In *epilepsy*, it has
remedy, proved succe
J. Johnson,[4] have all
medendi is imperfect
is considered that the
and that, as Dr. Sims
is involved in the gre
of a single fit, and th
ignorance, and with t
powers of this salt, th
conceiving how the b
the cure of a diseased
absurd and unwarrant
bably those termed by
I have seen this rem
continued long, on ac

In *chorea*, it has l
Dr. Crampton,[9] Lom
administered in the i
Cappe[11] and Dr. Cop

In *chronic affections of the stomach* (especially morbid sensibility of the gastric and intestinal nerves) it has been favourably spoken of by Autenreith,[1] Dr. James Johnson,[2] and Rueff.[3] It has been employed to allay chronic vomiting connected with disordered innervation, as well as with disease of the stomach (scirrhus and cancer), and to relieve gastrodynia. The foregoing are the most important of the diseases against which nitrate of silver has been administered internally. [During the epidemic cholera of 1849, Mr. G. Ross[4] gave the nitrate of silver, in grain doses, in seventy of the worst form of cases; *i. e.* 70 cases out of 853, in which other means having failed, the nitrate was had recourse to as a last resource: of this number only 5 died. Nitrate of silver has also been used in the form of injection in cases of cholera, upon the indication of the necessity therein existing for the arrest of the destructive flow of saline matters from the bowels.[5]—ED.]

As an *external agent*, its uses are far more valuable, while they are free from the inconvenience of permanently staining the skin. It is employed sometimes as a *caustic*, and as such it has some advantages over potassa fusa and the liquid corrosives. Thus, it does not liquefy by its application, and hence its action is confined to the parts with which it is placed in contact. It is used to remove and repress spongy granulations in wounds and ulcers, and to destroy warts, whether venereal or otherwise. It is applied to chancres on their first appearance, with the view of decomposing the syphilitic poison, and thereby of stopping its absorption, and preventing bubo or secondary symptoms. This practice has the sanction of Mr. Hunter. I have several times seen it fail, perhaps because it was not adopted sufficiently early. The nitrate should be scraped to a point, and applied to every part of the ulcer. This mode of treating chancres has been recently brought forward by Ratier[6] as if it were new, and as forming part of Bretonneau's *ectrotic* (*ectrotica*, from *ἐκτιτρώσκω*, *I abort*) method of treating diseases! [M. Robin,[7] of St. Etienne, states that an ointment of nitrate of silver, in the proportion of about one part to fifteen, is very efficacious in promoting the resolution of buboes, or in expediting the removal of thickening where the abscess has suppurated and been opened.—ED.]

The application of nitrate of silver to *punctured wounds* is often attended with most beneficial effects, as Mr. Higginbottom[8] has fully proved. It prevents or subdues inflammatory action in a very surprising manner. It is equally adapted for poisoned as for simple wounds. To promote the healing of *ulcers* it is a most valuable remedy. In large indolent ulcers, particularly those of a fistulous or callous kind, it acts as a most efficient stimulant. To small ulcers it may be applied so as to cause an eschar; and when at length this peels off, the sore is found to be healed. Mr. Higginbottom[9] asserts, that "in every instance in which the eschar remains adherent from the first application, the wound or ulcer over which it is formed invariably heals."

---

[1] Dierbach, *Die neuesten Entdeckungen in der Mat. Med.* 1837, i. 528.

[2] *On Indigestion*, 2d edit. p. 87.

[3] Dierbach, *op. cit.*; also *American Journal of Medical Science*, May 1837, p. 228.

[4] *Medical Times*, vol. xx. p. 224.

[5] *Ibid.* vol. xix. p. 268.

[6] *Arch. Gén. de Méd.* xv. 47; and xvi. 62.

[7] *Bulletin Thérap.* t. xxxvii. 380.

[8] *Op. cit.*

[9] *Op. cit.* p. 11.

iodine preferable. [M.
viceable in pleurodynia
Bretonneau and Se
tules by nitrate of silv
pally useful as a means
first or second day of th
pustule after the apice
been employed in the t
disease was cured in a f
been laid down by Ray
In some diseases of
agent. It is used in t
tion may be used as a w
In deep ulcers of the c
in superficial ones, a s
ounce of distilled water
use of this substance
of the eye: viz. the d
staining the conjunctiv
ployed it in many hu
In both acute and chro
form of ointment (Arg. N
Ung. Cetacei, ʒj.) Of
pin's head to that of a
finger or a camel's hair
lasts only half an hour,
are to be used, and the
In acute cases, two or
treatment, blood-letting,
conjoined.[10] While ma

---

stage of acute purulent ophthalmia, all are agreed as to its value in the second stage of the disease, as well as in chronic ophthalmia. Besides the diseases of the eye already mentioned, there are many others in which the oculist finds this salt of the greatest service as a caustic, astringent, or stimulant.[1]

In *inflammatory affections and ulcerations of the mucous membrane of the mouth and fauces*, nitrate of silver is sometimes a most valuable application.[2] When the fibrinous exudation of croup commences on the surface of the tonsils and arches of the palate, its further progress may be stopped, according to Mr. Mackenzie,[3] by the application of a solution composed of a scruple of nitrate of silver and an ounce of distilled water. The solid nitrate has been introduced through an aperture in the trachea, and applied to ulcers on the inner surface of the larynx in a case of phthisis larynges, with apparent benefit.[4] [Nitrate of silver in solution, of the strength recommended by Dr. Green, of New York (viz. ʒj. to ℥j.), has been used with the most satisfactory results in inflammatory affections of the mucous membranes of the mouth, fauces, and pharynx. A case is related by Mr. Kesteven,[5] in which severe inflammation of the epiglottis, with all its distressing symptoms, was immediately relieved by the application of a strong solution of this salt, and within twelve hours deglutition was completely restored. Dr. Lockwood[6] has found a similar solution applied to the Schneiderian membrane a successful means of arresting catarrh in its early stages. Mr. J. D. Brown,[7] of Haverfordwest, reports the good effects of a strong solution of nitrate of silver in quinsy.—ED.]

In some forms of *leucorrhœa*, the application of nitrate of silver, either in the solid state or in solution, is attended with beneficial effects. This practice was first recommended by Dr. Jewel.[8] It is, I believe, most successful in cases dependent on local irritation or subacute inflammation, and not arising from constitutional debility. The solution may be applied by a piece of lint or sponge, or may be injected by means of a syringe with a curved pipe. Its strength must vary according to circumstances. Dr. Jewel generally employed three grains of the nitrate to an ounce of water; but in the Lock Hospital, solutions are sometimes used containing half a drachm, or even two scruples, to the ounce. In some cases the solid nitrate has been applied to the cervix uteri and vagina by means of a silver tube. In *gonorrhœa of the female*, a solution of the nitrate of silver, or even this caustic in the solid state, has been used with the best effects. It was first employed by Dr. Jewel, but subsequently, and on a much more extended scale, by Dr. Hannay,[9] and without any injurious consequences. In many cases the discharge ceased, never to return, in twenty-four hours. The fear of ill effects has prevented the general adoption of this practice. In *gonorrhœa of the male*, the introduction of a bougie, smeared with an ointment of nitrate of silver, and the nipple afterw

---

[1] Vide Dr. Mackenzie's *Treatise on Diseases of the Eye*; and Mr. Ryall's paper, in the *Trans. of the King and Queen's College of Physicians in Ireland*, v. 1.

[2] Hunt, *Lond. Med. Gaz.* xiii. 129.

[3] *Edinburgh Medical and Surgical Journal*, xxiii. 294.

[4] Liston, *Elements of Surgery*, part ii. p. 256.

[5] *London Medical Gazette*, vol. xliii. p. 761.

[6] *Edinb. Monthly Journal*, June 1849.

[7] *Med. Times*, vol. xx. p. 61.

[8] *Practical Observations on Leucorrhœa*, 1830.

[9] *Lond. Med. Gazette*, xx. 185.

The application of s
different forms of *por*
should be well rubbed
fail, or to cause the lo
involved, the different
some days; for, as alre
in a child from the too
medicine was found b
the nitrate is also valu
impetigo. The solid
irritative or erysipelat
around, and at a little
quently observed the i
Higginbottom[5] reports
burns and *scalds;* an
Mr. Cox.[6]

In strictures of the
caustic on their points
ployed with great adv
common bougie (*cereol*
heated with a conical pi
is quite soft. The poin
on a piece of polished
[Lunar caustic, fused i
Chassaignac[8] for operati
of the caustic might be
cation of nitrate of silve
Mr. Hunter, Sir E. Hou
but little employed; yet
where the simple bougie

is followed by a relaxation of the narrowed portion of the canal, but which change is as difficult to explain as the subduction of the internal inflammatory action by the application of this salt. Of the use of the caustic bougie in stricture of the œsophagus I have no experience.

ADMINISTRATION.—Nitrate of silver may be exhibited in doses of one-sixth of a grain, gradually increased to three or four grains, three times a day. As before mentioned, Dr. Powell has increased the dose to fifteen grains. The usual mode of administering it is in the form of pills made of bread-crumb; but the chloride of sodium which it contains renders it objectionable: some mild vegetable powder with mucilage is preferable. Common salt or salted foods should not be taken either immediately before or after swallowing these pills. Dr. Johnson[1] asserts "that there is no instance on record where the complexion has been affected by the medicine when restricted to three months' administration." It is advisable, however, not to continue the use of it beyond a month or six weeks at a time. [The inhalation of nitrate of silver has been proposed by Dr. T. K. Chambers,[2] in order to obtain its direct application to the air-passages. A light innocuous powder, such as the pollen of the lycopodium, or club-moss, is allowed to take up as much as it will of a saturated solution of the salt, and is then carefully dried and powdered. Two grains and a half of the powder thus prepared by Mr. Squire were found to contain one grain of nitrate. A glass funnel, or other apparatus for the especial purpose, serves for the introduction of the powder. Dr. Chambers observes, that its employment is attended with far less cough and spasm than the application of a sponge to the glottis.—ED.]

For external use, an aqueous solution is employed, of strengths varying from a quarter of a grain to two scruples, in an ounce of distilled water. The formula for Mr. Guthrie's ointment has already been given.

ANTIDOTE.—The antidote for nitrate of silver is common salt (*chloride of sodium*). When this comes in contact with lunar caustic, nitrate of soda and chloride of silver are produced: the latter compound is, according to the experiments of Orfila,[3] innocuous. The contents of the stomach should be removed, and the inflammatory symptoms combated by demulcents, blood-letting, and the usual antiphlogistic means. When the local use of nitrate of silver causes excessive pain, relief may be gained by washing the parts with a solution of common salt. Pieces of caustic have been left in the vagina and urethra without unpleasant consequences resulting. Injections of a solution of common salt are the best means of preventing bad effects.

To diminish the slate-coloured tint of the skin arising from nitrate of silver, acids or the super-salts offer the most probable means of success. The external and internal use of dilute nitric acid, or the internal employment of bitartrate of potash, may be tried: the discoloration is said to have yielded to a steady course of the last-mentioned substance.[4]

1. LIQUOR ARGENTI NITRATIS, *recens præparatus*, L.; *Solutio Argenti Nitratis*, E.; *Solution of Nitrate of Silver*. (Nitrate of Silver, in crystals, ʒj. [grs. xl., *E.*]; Distilled Water, f℥j. [grs. 1600, *E.*] Dissolve the

---

[1] *Essay on Morbid Sensibility of the Stomach and Bowels*, 2d edit. p. 90.

[2] *London Medical Gazette*, vol. xliii. p. 689.

[3] *Toxicol. Générale.*

[4] *United States Dispensatory.*

ORDER XXXI

]

Sy

HISTORY.—Gold has l
It was in common use
with which mankind was
metallorum,*.

NATURAL HISTORY.—]
alloyed with other metal
It occurs in veins in prin
small lumps or particles,
Europe, Asia, and Africa
part. [It has been largely

PREPARATION.—The n
principally according to tl
as possible from foreign n
ing), and sometimes by ro
to separate the stony m
submitted to cupellation;
distilled.

The separation of gold
way by fusion either witl
silver are procured, or w
of silver and an alloy of g
metal may be separated b

sp. gr. of 19·2 to 19·4; is soft, very ductile, and malleable;[1] fuses at a bright red heat (2016° F., according to Daniell); and in the liquid state has a brilliant greenish colour.[2]

Characteristics.—Gold is readily distinguished by its colour and softness, by its being unacted on by nitric acid, and by its ready solubility in nitro-hydrochloric acid. The solution is yellow, stains organic matters (as the skin) purple, throws down, by the addition of protosulphate of iron, metallic gold in a finely-divided state; by protochloride of tin, a dark or purple-black precipitate; and by protonitrate of mercury, a black precipitate: heated with borax by the blowpipe, it forms a pink or rose-coloured glass, but is subsequently reduced.

PHYSIOLOGICAL EFFECTS.—Gold, like other metals, has been frequently supposed to be inert while it retains its metallic condition, but in this, as well as in some other instances, the accuracy of the assumption has been denied. Both Chrestien[3] and Niel,[4] as well as other writers, assert that finely-divided metallic gold (*pulvis auri*) produces the same constitutional effects as those caused by the various preparations of this metal, but in a milder degree, while it excites little or no irritation. It is said to promote the secretions of the skin, kidneys, and salivary glands.

USES.—It has been employed as an antivenereal and antiscrofulous remedy by Chrestien, Niel, and others, with considerable success. It is said to be preferable to the other preparations of this metal in delicate and nervous subjects, females, and infants. Gold leaf (*aurum foliatum* seu *lamellatum*) is used by dentists for filling decayed teeth, and was formerly employed by apothecaries for covering pills (*ad inaurandas* seu *obducendas pilulas*).

ADMINISTRATION.—It has been administered internally in doses of from a quarter of a grain to a grain three or four times a day. Chrestien used it by way of friction on the tongue and gums. Niel employed it endermically (that is, applied it to the skin deprived of the epidermis) in the form of ointment, composed of one grain of gold and thirty grains of lard.

PULVIS AURI (Fr. Cod.), or *Powder of Gold*, is prepared by rubbing leaf gold (*aurum in laminas exilissimas complanatum*) with sulphate of potash, sifting, and washing with boiling water to remove the sulphate; or by adding protosulphate of iron to terchloride of gold, and by washing cipitate first with water, then with dilute nitric acid.

---

[1] [Gold is the most malleable of metals. It may be beaten into leaves having a thickness of not more than the 1-280,000th of an inch. The finest leaves of pure gold are transparent, and the light which traverses them has a rich green colour,—the complementary colour of that seen by reflected light: this, when the white light is subdued, is a brilliant copper-red. The purity of gold and its freedom from silver are known by the colour of the transmitted light. A very minute quantity of silver gives a bluish tint to the green colour. Gold and silver are the only two metals which become transparent by malleation.—ED.]

[2] [*Aurum.*—Pure gold is mentioned in the *Appendix to the London Pharmacopœia* among the tests for determining the purity of medicines. In the metallic state it is but little used for this purpose. It is occasionally applied for the separation of mercury from its soluble salts. (See Tests for Corrosive Sublimate, *ante*, p. 931.) For this purpose a small slip of gold foil, bound round spirally with a slip of zinc foil, is introduced into the suspected liquid, which should be only slightly acidulated. If a soluble salt of mercury be present, the yellow colour of the gold is speedily lost; it acquires a greyish-white coating, while the zinc is more or less dissolved. The coated piece of gold foil should be well washed in water and ether, then dried and heated in a small tube, when mercury will be sublimed in globules easily recognisable by the eye or under the microscope. In this way the analyst may detect mercury in arsenical or other metallic solutions.—ED.]

[3] *Sur une Nouvelle Remède dans le Traitement des Mal. Vén.* Paris, 1811.

[4] *Recherches et Observations sur les Effets des Préparations d'Or*, Paris, 1821.

192. AURI TEROXYDUM.—TEROXIDE OF GO

Formula AuO^3. *Equivalent Weight* 223.

This substance, sometimes called *peroxide of gold, auric oxide, acid,* is ordered, in the French Codex, to be prepared by boiling 4 calcined magnesia with 1 part terchloride of gold and 40 parts Then wash, first with water, to remove the chloride of magnesium, a with dilute nitric acid, to dissolve the excess of magnesia.

Teroxide of gold is brown; in the state of hydrate, reddish-yello reduced by heat and solar light. It is insoluble in water, but is hydrochloric acid (forming terchloride of gold) and in alkalies aurates).

It is used internally, in venereal and scrofulous diseases, in dose one-tenth of a grain to a grain, made into the form of pills, with mezereon.

1. **AURUM FULMINANS**; *Fulminating Gold; Aurate of Am Ammoniuret of Teroxide of Gold.*—This is prepared by adding am a solution of chloride of gold. It is a yellowish-brown powder, which when heated to 400°. Its composition is probably $2NH^3,AuO^3$. been employed in the same cases as the preceding compounds, as w fevers and nervous affections. In some cases it has produced ver and even fatal results.[1]

2. **PURPURA MINERALIS CASSII**; *Purple of Cassius; Aurum paratum,* Fr. Cod.—There are several methods of preparing it: the is to add a solution of the mixed protochloride and perchloride of solution of terchloride of gold until a precipitate is no longer p Filter, and dry the precipitate.

The purple of Cassius is soluble in ammonia, and does not form an a with mercury: hence it does not appear to contain any metallic go composition probably varies according to the mode of procuring it. oxygen, and tin, are its essential constituents. According to Fuchs, i position is $2(SnO,SnO^2)+AuO^2SnO^2+Aq$.

This preparation is used in the same cases as the other preparations

193. AURI TERCHLORIDUM.—TERCHLORIDE OF G

Formula $AuCl^3$. *Equivalent Weight* 305·5.

PREPARATION.—In the French Codex this is ordered to be prep dissolving, with the aid of heat, one part of gold in three parts of hydrochloric acid. The solution is to be evaporated until vapours of c begin to be disengaged, and then allowed to crystallise.

PROPERTIES.—Terchloride of gold is in the form of small crystalline of a deep orange-red colour, inodorous, and having a strong, styptic, disagreeable taste. It is deliquescent, on which account it should be preserved in a well-stoppered bottle: it is soluble in water, alcohol, and ether, [forming rich yellow-coloured solutions. Ether will remove it from its solution in water.—ED.] When heated, it evolves chlorine, and is converted, first into protochloride, and then into metallic gold, which is left in the spongy state. It reddens litmus, stains the cuticle [and all organic matter under the influence of light] purple, is reduced by many metals (as iron, copper, tin, and zinc), by several of the non-metallic elementary substances (as phosphorus), by some metallic salts (as protosulphate of iron), and, under exposure to light, by many organic bodies (as charcoal, sugar, gum, gallic acid, and extractive), all of which, therefore, are incompatible with it. Nitrate of silver occasions a precipitate of chloride of silver and oxide of gold: hydrochloric acid removes the latter.[1]

---

[1] Plenck, *Toxicologia*, ed. 2nda, 230.

PHYSIOLOGICAL EFFECTS. *α. On Animals.*—Orfila[2] examined the effects of chloride of gold on animals, and infers from his experiments, that when introduced into the stomach it acts as a corrosive (but with less energy than the bichloride of mercury), and destroys animals by the inflammation of the coats of the alimentary canal which it sets up.

β. On Man.—On man its effects are analogous to those of bichloride of mercury. In *small doses* it acts, according to Dr. Chrestien, more energetically as a stimulant, though less powerfully as a sialogogue, than corrosive sublimate. It promotes the secretions of the skin, the salivary glands, and the kidneys. Taken to the extent of one-tenth of a grain daily, it has occasioned violent fever. "This excitation," says Chrestien, "I regard as indispensably necessary for the cure of the diseases against which I administer gold: restrained within proper limits, it is never accompanied with any remarkable or even sensible lesion of the functions. The mouth is good, the tongue moist, the appetite continues, the bowels are not disordered, and there is ordinarily only augmentation of urine and transpiration; but if carried too far, we incur the risk of producing general erethism, inflammation of this or that organ, according to the predisposition of the patient, which will not only check the treatment, but may even induce a new disease, often more troublesome than the original one. The suspension or modification of the remedy should be governed by the unusual and sustained heat of the skin." Cullerier,[3] the nephew, has seen one-fifteenth of a grain excite, at the second dose, gastric irritation, dryness of the tongue, redness of the throat, colic, and

---

[1] [In consequence of the facility with which chloride of gold is reduced by organic matter, it has been proposed as a test by M. Dupasquier for the detection of organic matter in water. An ounce or two of the water to be examined is to be poured into a flask, and a few drops of the solution of chloride of gold added, sufficient to colour it slightly yellow; the liquid is then to be boiled. If the water contain only the quantity of organic matters usually present in drinkable water, it will retain its yellow colour unaltered even during prolonged ebullition. If, on the contrary, the water contain an abnormal proportion of organic matter, it will in the first instance become brownish, and afterwards assume a violet or bluish tint, arising from the decomposition of the salt of gold by the organic matter. The more decided the blue or violet tint, the greater the quantity of organic matter. A few drops of hydrochloric acid added to the water will prevent decomposition of the salt of gold by carbonate of lime. The decomposition is more readily effected by the matters resulting from spontaneous decomposition of animal or vegetable remains, than by unaltered organic matter. (*Pharm. Journal*, 1849, p. 433, quoted from the *Journal de Pharmacie*.)—ED.]

[2] *Toxicol. Gén.*

[3] Magendie, *Formulaire*, 8me édit. p. 305.

diarrhœa. When it pr
affect the teeth and gu
by nervous symptoms (
sleep), and afterwards g
erections. In *large d*
to those produced by th

Uses.—It has been
mercury in the seconda
of it is, however, neces
confidence. In the ha
others, it has proved
lous affections, bronch
Duportal[7] cured with i
by him as cancerous,
cure.

Legrand[8] has used ch
in syphilitic, scrofulous,
rations of the neck of t
tubercles, and ulcers, c
when the crust separat
which remains afterwar
are employed. It is p
three parts, nitric acid on

Administration.—I
of a grain, made into pill
it is better to use it in di
quantities of from one-si

Antidote.—The same

194. AURI

Forn

This is ordered to be
of iodide of potassium tc
sition takes place, and i
$3KCl+2I$. This is to
remove the excess of iodi

Iodide of gold is of a
slightly soluble in boilin
vapour, and is converted i

It has been employed

---

[1] Grötzner, Rust's
[2] *Op. cit.*
[3] *Op. cit.*
[4] *Op. cit.*
[5] *Dict. des Sciences*
[6] *De l'Or ; de son*
[7] *Ann. de Chim.* lxx
[8] *Lond. Med. Gaz.* x
[9] *Gazette Médicale*

one-fifteenth to one-tenth of a grain. Externally, it has been applied in the form of ointment to venereal ulcers.[1]

195. SODII AURO-TERCHLORIDUM. – AURO-TERCHLORIDE OF SODIUM.

Formula $NaCl, AuCl^3, 4HO$. *Equivalent Weight* 400.

In the French Codex this is ordered to be prepared by dissolving 85 parts by weight of terchloride of gold, and 16 parts of chloride of sodium, in a small quantity of distilled water: the solution is to be evaporated by a gentle heat until a pellicle forms, and then put aside to crystallise.

The auro-terchloride of sodium crystallises in orange-coloured, quadrangular, elongated prisms, which are permanent in the air; but when they contain any uncombined terchloride of gold, they are slightly deliquescent. They are soluble in water. When heated, chlorine is evolved, and a mixture of gold and chloride of sodium is left behind.

Its effects and uses are analogous to the terchloride of gold, over which it has the advantages of being more constant and less costly. It is exhibited internally in doses of one-twentieth to one-tenth of a grain, made into pills with starch or lycopodium. Mixed with twice its weight of orris powder or lycopodium, it may be used in frictions on the tongue and gum. An ointment (composed of one grain to thirty-six grains of lard) may be applied endermically to the skin, deprived of its epidermis by a blister.

196. AURI TERCYANIDUM. –TERCYANIDE OF GOLD.

Formula $AuCy^3$. *Equivalent Weight* 277.

The directions for preparing this salt, in the French Codex, are somewhat diffuse. The process consists essentially in very carefully adding a solution of pure cyanide of potassium to a solution of chloride of gold, until a precipitate (*cyanide of gold*) ceases to be formed. The chloride of gold, prior to solution, should be deprived of all excess of acid by heating it in a salt-water bath.

Cyanide of gold is a yellow powder, which is insoluble in water. It has been used in venereal and scrofulous affections, both externally and internally. The dose is from one-fifteenth to one-tenth of a grain, made into a pill with some inert powder.

ORDER XXXII. COMPOUNDS OF PLATINUM.

197. Platini Bichloridum. – Bichloride of Platinum.

Formula $PtCl^2$. *Equivalent Weight* 170.

Perchloride of Platinum; *Muriate of Platinum*; *Nitromuriate of Platinum*.—Obtained by dissolving platinum in nitro-hydrochloric acid, and by evaporation, prismatic crystals of

---

[1] Ferguson, *Journ. de Progrès*.

the hydrated bichloride of plat
a dark reddish-brown, deliqu
($PtCl^2$) is obtained. It is sol
body have been investigated
caustic poison. Given to rabl
and death. Considered in rel
chloride of gold and perchlorid
syphilis. Dose from one-eigh
may be administered either in
of pills. An ointment com
extract of belladonna, and an
compound is enumerated amon
It is a valuable test for potash

198. Sodii Platino-B

Formula

Sodio-bichloride of Platinu
Natronatum.—Obtained by di
of pure chloride of sodium in
be mixed and evaporated so
lose their water of crystallisat
$NaCl,PtCl^2$, in the form of a y
Its general effects are simila
and for medicinal use it is
medicinal uses the auro-terchl
and some other maladies. Th
in the form of powder, pill, c
posed of ʒss. dissolved in half
in gonorrhœa. A liniment co
has also been used.[3]

---

[1] *Versuche über die Wirkunge*
[2] *Observations et Recherches e*
t. xxvii. 1841.
[3] For further details respecting
referred to Dierbach's *Neuesten I*

APPENDIX.

Page 339. COMPOUNDS OF SILICON.—This elementary body is placed by the author among the metalloids, immediately after Boron. We subjoin the following notice respecting its properties and those of its only oxygen compound, *Silicic Acid* :—

ORDER V.* COMPOUNDS OF SILICON.

Silicon ($Si = 15$), also called Silicium, is the metallic base of the earth silica. It is found extensively distributed in both the organic and inorganic kingdoms. It was first obtained pure by Berzelius in the year 1824.

199. SILICA.—SILICIC ACID.

Formula SiO^3. *Equivalent Weight* 39.

HISTORY.—Silica constitutes a large portion of the globe. It has been known in its various forms from the remotest antiquity.

NATURAL HISTORY.—It occurs in both kingdoms of nature.

α. IN THE INORGANISED KINGDOM.—In the mineral kingdom silica exists in the form of flint, calcedony, sand, rock crystal or quartz, opal, and cornelian. It is also present in combination with various metals, forming silicates. It constitutes a large proportion of various volcanic rocks, lavas, &c., and is found dissolved in the waters of the fountains of Reikum, and in the Geysers of Iceland.

β. IN THE ORGANISED KINGDOM.—Silica is an important ingredient in many vegetable substances. It gives solidity to the stems of plants. The ashes of straw yield silica in large proportion, and the products of the combustion of nearly all woods, fruits, and seeds, are rich in silica. It is present in the blood, the urine, the bones, and various other animal matters.

PREPARATION.—For use in the arts silica is obtained from various sources and in various forms. It is reduced to the finest powder for use in the potteries; and for the rougher purposes of building is used in the native state as flint. In the form of sand it is an important ingredient of various glasses and of mortar. In order to obtain silica in the finest powder, the best quartz, or purest flint, is first heated red hot, and then suddenly cooled by being

projected into cold wate
when trituration has bee
fully levigated. It is th
the London College, in c
this purpose the silica is
the water, so that an inti
on filtration, yields a pe
tion of silica to oil and
of oil, and one gallon of

PROPERTIES.—Silica (
perfectly white, having a
by the oxyhydrogen blow
ing the hydrofluoric; bu
acids dissolve small prop
When fused with bases it
of which are soluble in w

Pages 231 and 345.
the form of a reddish-br
10 lbs. Commercially sp
There have, in the last tw
manufacture of matches,
the same object; but the
it is evident that a suita
desideratum, the superio
safety being undoubted.

Page 375. *Acidum Hy*
in the *Appendix to the L*
are given for its preparatio

Page 385. *Liquor Chl*
Acid, f℥j.; Powdered Bin
Mix the acid and binoxide
water until it nearly ceases

Page 399. *Iodinium pu*
directions for obtaining pu
venient quantity. Introdu
shape; and having covered
filled with cold water, appl
twenty minutes, and then,
Should the sublimate attach
prisms of a white colour an
rod and rejected. The mat
a gentle and steady heat (th
so as to sublime the entire c

the purified product will be found attached to its bottom. When separated, it should be immediately inclosed in a bottle furnished with an accurately ground stopper.

Page 400. *Iodine and its Impurities.*—We are indebted to a friend for the following commercial notice of iodine:—In English commerce we quote three qualities of iodine, namely—1st quality; 2d quality; and 3d, the re-sublimed:—

1. The first quality is dry, so as hardly to adhere to the inside of a bottle, and so as hardly to stain paper on which it may be placed for a short time. It is produced chiefly by one firm.

2. The second quality is more or less damp, and is produced by a great variety of makers. It fetches from 5 to 10 per cent. less than the first quality; and both are brought into the market in barrels of 112 lbs. nett.

3. The re-sublimed. This is in large flakes, and is prepared, not by the iodine manufacturers, but by refiners. Its value is about 3d. per ounce greater than that of the first quality, and it is packed in bottles to order.

To prove the extensive use of this article in medicine and in the arts, it may be stated that when the speculative demand in the London market took place in October 1852, which drove the price suddenly up from 7½d. to 1s. 6d. per ounce, not less than 400 barrels of 112 lbs. was the stock on hand.

With the exception of *dampness*, no adulterations seem ever to be attempted by the English manufacturers and wholesale houses.

Page 414. *Sulphuris Iodidum*, L.; *Sulphur Iodatum*, D.—Take of Sulphur, ℥j. [Sublimed Sulphur, ʒij. *D.*]; Iodine, ℥iv. [Pure Iodine, ℥j. *D.*] Put the sulphur into a glass vessel, and place the iodine over it. Hold the vessel immersed in boiling water until they unite. When the iodide has become cold, break the vessel and beat the iodide into fragments, and keep it in another vessel well closed.

From a hundred grains of this, carefully boiled in water, about twenty grains of sulphur remain. The directions of the *Dublin* are much the same as those of the *London College*, with the exception that the *Dublin College* orders the iodine and sulphur to be triturated together, and does not direct that boiling water should be used to apply the heat necessary for effecting combination.

Page 594. *Cataplasma Sodæ Chlorinatæ.*—This preparation is given in the text, according to a formula by the author. We here subjoin the proportions of the ingredients as they are directed in the *London Pharmacopœia*:—Take of Boiling Water, f℥vj.; Linseed, in powder, ℥iss.; Solution of Chloride of Soda, f℥ij. Add the linseed powder gradually to the water, frequently stirring; then mix with this, the chloride of soda.—Applied to foul and sloughing ulcers.

Page 642. *Collins's Chloride of Lime.*—The chloride of lime known under the name of Collins's Patent Chloride is prepared by mixing one part

of anhydrous sulphate of alumina with two parts chloride of l
moistened or mixed with water, chlorine is liberated. It is us
fecting agent, but is more costly than the common chloride. T
addition of diluted sulphuric acid to the ordinary chloride answ
purpose.[1]

Page 659. *Enema Catharticum*, D.—Take of Sulphate of M
Olive Oil, f℥j.; Mucilage of Barley, f℥xvj. Dissolve the sulph
nesia in the mucilage, add the oil, and mix.

---

[1] *Pharmaceutical Journal*, 1850, p. 89.

END OF VOL. I.

London:
Wilson and Ogilvy,
Skinner Street.

INDEX

TO

DR. PEREIRA'S MATERIA MEDICA,

VOL. I.

1854.

INDEX TO VOLUME I.

PAGE

- ABORTIVA 270
- Absorbentia 180
- Absorption of Medicines 103
- Acarus scabiei 355
- Acetaria 227
- Acetate of alumina 671
  - ammonia 471
  - copper 877
  - iron 857
  - iron, tincture of .. 858
  - lead 803
    - and opium pills 808
  - mercury 954
  - potash 546
  - soda 596
  - zinc 776
- Acetated ceruse 803
- Acid, aerial 327
  - anhydrous or dry nitric 422
    - sulphuric .. 364
  - aromatic sulphuric 373
  - arsenious 682
  - auric 974
  - boracic 335
  - carbonic 327
  - chlorohydric 390
  - chloronitric 432
  - cocinic 601
  - diluted muriatic 395
    - nitric 430
    - sulphuric 372
  - English sulphuric 365
  - frozen sulphuric 365
  - fuming nitric 423
    - sulphuric 364
  - gaseous hydrochloric .. 387
  - glacial phosphoric 347
  - hydriodic 413
  - hydrochloric 387
  - hydro-oxalic 813
  - hydrosulphuric 375
  - iodic 412
  - liquid hydrochloric 390
    - oxymuriatic 385
  - margaric 601
  - marine 387
  - metaphosphoric 346
  - muriatic 387
  - native boracic 335
  - nitric 422
    - diluted 430
    - liquid 423
  - nitro-hydrochloric 432
  - nitro-muriatic 432
  - nitrous 426
  - Nordhausen or fuming sulphuric 364
  - oleic 601
  - oxalhydric 813
  - oxygenated muriatic .. 379

PAGE

- Acid, palmitic 601
  - phocenic 601
  - phosphoric 346
  - pyrophosphoric 346
  - saccharic 813
  - solid arsenious 686
  - stearic 601
  - sulpharsenious 690
  - sulphuric 359
  - sulphurous 373
  - vapour 327
  - vitriolated tartar 506
  - vitriolic 359
- Acids 97, 174
- Acidulo-alkaline waters 309
- Acidulous or carbonated waters 309
  - tartrate of potash 550
- Acidum arseniosum 682
  - boracicum 335
  - carbonicum 327
  - chloro-hydrargyricum 929
  - hydriodicum 413
  - hydrochloricum 387
    - dilutum 395
  - hydrosulphuricum .. 375
  - iodicum 412
  - muriaticum 387
    - dilutum 395
  - nitricum 422
    - dilutum 430
  - nitro-hydrochloricum 432
  - nitro-muriaticum .. 432
  - nitroso-nitricum ... 426
  - nitrosum 423
  - phosphoricum 346
  - sulphuricum 359
    - aromaticum 373
    - dilutum 372
    - purum 369
    - venale 367
  - sulphurosum 373
- Acology 1
- Acrids 168
- Adhesive plaster 812
- Adipsa 174
- Æolopile 20
- Aër 474
- Aerated magnesia water 654
  - mineral alkali 556
- Ærugo 877
  - crystallisata 880
- Æsthetica 208
- Ætherea 232
- Æthereo-oleosa 224
- Æthiops absorbens 903
  - martialis 820
  - mineral 916
- Affusion, warm 22
  - cold 29
  - cool 31

PAGE

- Affusion, tepid 31
- Ague drops, tasteless 710
- Agrypnotica 219
- Aikin's Ammonio-tartrate of iron 863
- Air, alkaline 434
  - atmospheric 474
  - cold 28
  - dephlogisticated 272
    - nitrous 419
  - fixed 327
  - inflammable 279
  - mephitic 418
  - phlogisticated 418
- Albumen, an antidote for corrosive sublimate 937
- Alkali, mineral 556
- Alcohol of sulphur 877
- Alcoholica 232
- Algaroth's powder 724
- Aliments 63, 82
  - compound 65
- Alimentary principles 63
- Alkali, aerated mineral 556
  - mild mineral or fossil 556
  - mild vegetable 489
  - vegetable 478
  - volatile 433
- Alkalina 180
- Alkaline air 434
  - salt 597
  - solution, Brandish's 483
  - waters 313
- Allopathia 127
- Allotropic phosphorus 231
  - sulphur 353
- Allyle 225
- Alnus glutinosa 320
- Alterants or alteratives 99
- Alternatives, voltaic 43
- Alum, antidote for 670
  - common or potash 662
  - dried 670
  - native 662
  - roch or rock 664
  - Roman 664
  - water (Bates's) 670
  - whey 669
  - alumen 662
    - exsiccatum .. 670
    - potassicum .. 662
- Alumen ferricum 670
- Alumina 660
  - hydrate of 660
- Aluminæ acetas 671
- Aluminum, compounds of .. 660
- Amanita muscaria 108
- Amara 215
  - pura 215
- Amblotica 271

PAGE
Amblothridia 271
Amide theory, Kane's 436
Amido-chloride of mercury.. 938
Ammonia 433
    acetate of 471
    or ammoniacal gas 434
    Berthollet's neutral
        carbonate of 457
    citrate of....... .. 473
    ferrico citrate of .. 860
    hepatised 465
    hydrochlorate of .. 458
    hydrosulphates of 465
    hydrosulphuret of 465
    liniment of 445
    sesquicarbonate of 457
    muriate of 458
    neutral carbonate of 449
    neutral hydrosulphuret of 466
    nitrate of 470
    ointment of 446
    oxalate of 474
    spirit of 446
    subcarbonate of .. 451
    sulphate of 470
    tartrate of 473
    water of 437
Ammoniacal gas 434
Ammoniacalia 230
Ammoniæ acetas............. 471
    acetatis aqua 471
        liquor.... 471
    aqua 437
    bicarbonas 457
    bihydrosulphas .. 465
    carbonas 451
    carbonates 447
    carbonatis aqua .. 457
    causticæ aqua 437
    citras 473
    cupro-sulphas 875
    ferrico-citras 860
    hydrochloras 458
    hydrosulphates .. 465
    hydrosulphuretum 465
    liquor 437
        fortior 439
    monocarbonas.... 449
    murias 458
    nitras 470
    oxalas 474
    sesquicarbonas .. 451
        pyro-oleosa 457
    sesquicarbonatis liquor 457
    sulphas 470
    tartras 473
Ammonioretum cupri 875
Ammonio-chloride of mercury 938
Ammonio-sulphate of the peroxide of iron 671
Ammoniated submuriate of mercury 938
Ammonium, chloride of 458
    theory, Berzelius's 436
Ammoniuret of teroxide of gold 974
Amorphous or black sulphuret of mercury 916
    tersulphuret of antimony 734
Anacathartica 243
Anæsthetica 278
Analeptica 224
Anaphrodisiaca 269
Anatripsologia.............. 150
Animal black.. 322
    charcoal 322
        purified.... 326
    oil, soda soap 603
Antacida 180

Astringent pills [illegible]
Astringents [illegible]
vegetable, para [illegible]
Astringents [illegible]
Atmospheric air [illegible]
[illegible]
Aurum [illegible]
[illegible]
Azote [illegible]
Azote, carburetted hydrogen [illegible]

B

Baker's salt [illegible]
[illegible]
Barytes [illegible]
[illegible]
Baths [illegible]
medicated vapour [illegible]
water [illegible]
[illegible]

Baths, hot [illegible]
[illegible]
Borax [illegible]
[illegible]

Boyle's [illegible] 911
[illegible] 16
[illegible] 16
[illegible]
Bronchotomy [illegible]
[illegible]

C

[illegible]
Calomel [illegible]
[illegible]

PAGE
- Carbonas plumbi 793
  - potassæ 488
  - sodæ 556
  - zinci 768
  - zinci impura 767
    - impurum præparatum 767
- Carbonate of ammonia 447
  - iron 827
  - lead 793
  - lime, neutral 620
  - lithia 606
  - zinc 766
- Carbonated waters 309
  - chalybeate waters 307
- Carbonates of ammonia 447
  - lime 620
  - potash 488
- Carbonic acid 327
  - water 333
- Carbonicum acidum 327
  - natrum 556
- Carbonii bisulphuretum 377
- Carbonium 317
- Carburet or percarburet of iron 319
  - of sulphur 377
- Carburetted hydrogen 72
- Carminatives 224
- Carron oil 619
- Carthusian powder 734
- Cassius, purple of 974
- Castile soap 602
- Cataleptica 217
- Cataplasma carbonis ligni 322
  - catharticum 982
  - sodæ chlorinatæ 594, 981
- Cathæretics 161
- Cathartica 246
- Cathartics or purgatives 246
- Caustic potash 486
  - lunar 961
  - or quick lime 615
- Caustics (caustica) 161
- Cauterisation objective 15
- Cauterium potentiale 486
- Cautery, the actual 17
- Cerate, Kirkland's neutral 813
- Cerate of sugar of lead 808
  - Turner's 768
- Ceratum arsenici 721
  - calaminæ 768
  - epuloticum 768
  - hydrargyri compositum 908
  - plumbi acetatis 808
    - compositum 810
  - saponis 605, 753
    - compositum 605
- Cerebro-spinals 219
- Cerussa or ceruse 793
  - acetata 803
  - citrina 790
- Chabert's oil 238
- Chalcanthum 835
  - Cyprium 871
- Chalk 620
  - compound powder of 624
  - lozenges 625
  - mixture 624
  - prepared 621
- Chalybeated tartar 864
- Chalybeate waters 305
- Chalybeates 193
  - carbonated 307
- Chalybs cum sulphure præparatus 833
- Charcoal, animal 322
  - cataplasm 322
- Charcoal poultice 322
  - purified animal 326
  - wood 320
- Chili saltpetre 594

PAGE
- Chlorate of potash 509
- Chloride of ammonium 458
  - barium 610
  - calcium 628
  - lead 797
  - lime 631
  - mercury 919, 929
  - potassium 508
  - silver 959
  - soda 589
  - sodium 580
  - zinc 772
- Chloridum barii 610
  - calcii 628
  - hydrargyri 919, 929
  - sodii 580
- Chlorinated lime 631
- Chlorine 379
  - water 385
- Chlorinium 379
- Chloro-amide of hydrogen 459
- Chloro-nitric acid 432
- Chloruret of the oxide of
  - calcium 631
  - sodium 589
- Choke-damp 328
- Cholagoga 255
- Chromates of potash 672
- Chromic acid 671
- Chromium, compounds of 671
- Cineres clavellati calcinati 489
  - crudi 489
  - vegetabilium, seu cineres e lignis combustis 489
- Cinetica 211
- Cinis antimonii 726
- Cinnabar 914
- Cinnabaris 914
- Citrates of iron 860
- Citrine ointment 952
- Classification of medicines 137
- Climate 70
- Clysters 134
- Coagulated mercury 910
- Cobalt 682
- Cœliaca 133
- Cœlelmintha 234
- Coil machines 56
- Colcothar 823
- Cold 23
  - by conduction 28
  - evaporation 28
  - mineral waters 305
  - radiation 28
- Coniferæ 85
- Contra-stimulants 99
- Contrefeyn 761
- Convulsiva 216
- Copper and its compounds 867
  - acetates of 877
  - ammoniated 875
  - bisulphate of 871
  - diacetate of 877
  - rust of 877
  - subacetate of 877
  - sulphate of 871
- Copperas 835
  - blue 871
  - green 835
  - white 769
- Coral, red, prepared 622
- Cordials 224
- Corn, constituents of 67
- Cornu ustum 626
- Cornus sanguinea 320
- Corpse-lights 60
- Corrosive muriate of mercury 929
  - sublimate 929
- Cosmetic mercury 938
- Cosmétique infallible 802
- Counter irritation 127

- Counter-irritating or ant
  noos lotions
- Cow-houses, residence in
- Coxæluvium
- Crab's claws, prepared
  - stones, prepared
- Cream of tartar
  - soluble
  - whey
- Cremor tartari solubilis
- Creta
  - alba
  - præparata
- Cretaceous mixture
- Crocus antimonii
  - martis
- Crystals, systems of
- Cubic nitre
- Cucurbitaceæ
- Cupri acetas
  - acetates
  - ammoniati aqua
    - solutio
  - ammoniaretum
  - ammonio-sulphas
  - subacetates
- Cupro-sulphate of ammon
- Cuprum
  - aluminatum
  - ammoniatum
- Cure, cold water
  - psychical method of
- Cyanide of gold
  - mercury
  - potassium
  - silver
  - zinc
- Cyprus vitriol

D.

- Darkness
- Decocta
- Decoctions
- Decocta-infusa
- Delcroix's poudre subtile
- Demulcents
- Dentifrices
- Dentrificium calcis chlorin
- Deodorizers
- Depilatories
- Dephlogisticated air
  - nitrous ai
- Derivation and revulsion
- Desiccants
- Diachylon or diachylum
- Diamond
- Diapnoica
- Diaphoretica
- Dichloride of sulphur
- Diluents
- Disinfectants
- Diuretica
- Diuretic salt
- Doctrine of contra-stimul
  new Italian
- Dolomite
- Donovan's solution
- Doses of medicines
- Doubles
- Douche, eye
  - the
  - topical
  - vapour
- Drago mitigatus
- Drastica
- Drinks
  - aqueous
  - cold

Page
Durcia 31
Dung, hot, for baths 73

E.

Earth of bones 626
Earth, Fuller's 661
Earth of Lemnos 661
Eau de Javelle 592
  luce 446
Ecbolica 270
Eccoprotica 247
Eccritica 239
Effects 1
Effervescing draughts 333
  solution of potash 497
Elaïl 365
Elaïdine 954
Electric action of medicines 91
  aura 51
  bath 51
  calamine 767
  current 52
  friction 50
  machine 50
  shock 52
  spark 51
  vibration 52
Electrical battery 53
  contact 53
Electricity, chemical 51
  frictional 50
  magnetic 56
  voltaic 53
  Electrogens 53
  Electro-puncture 56
Elixir of vitriol 373
Embrocatio iodinii 411
Emetic tartar 761
Emetics (emetica) 263
Emmenagoga 269
Emollients 170
Emplastrum adhærens [illegible]
  adhæsivum 812
  ammoniaci cum hydrargyro 809
  cum hydrargyro 809
  ammoniæ hydrochloratis [illegible]
  ferri 826
  hydrargyri [illegible]
  iodinii 412
  lithargyri 791, 811
  lithargyri cum resina 812
  picis 811
  resinæ 812
  [illegible] 812
  [illegible] 826
  saponis [illegible]
  thuris 826
[illegible] 230
Endermic method 130
[illegible] 96
Enemata [illegible] 661
  communis 509
Enterica 213
Epidermic method 130
Epispastica 169
Epsom salts 655
Errhina 260
Eschar [illegible] 161
Ethiops mineral 916
Evacuantia 239
Excitantia 223
Excreta animalia [illegible]
Exercise 60
[illegible] 96

Page
Expectorantia 241
Extract, Goulard's [illegible]
Extractum saturni [illegible]

F.

Faith 6
Fear 6
Febrifugum magnum 35
Feelings 5
Ferri acetas 837
  acetatis tinctura 838
  ammonio-citras 840
  ammonio-chloridum 845
  arsenias 836
  carbonas 827
    saccharatum 828
  citrates 840
  ferro-sesquicyanidum 832
  fila 818
  filum 818
  iodidum saccharatum 852
  iodidum 847
  iodidi syrupus 851
  lactas 839
  limatura 818
  muriatis tinctura 841
  oxydi squamæ 821
  oxydum nigrum 820
    rubrum 822
  pernitras 855
  persulphas 840
  phosphates 831
  potassio-tartras 844
  pulvis 819
  ramenta 818
  rubigo 821
  scobs 818
  sesquichloridum 840
  sesquioxydum 822
    hydratum 834
  subperphosphas 832
  sulphas 835
    exsiccatum 839
  sulphuretum 843
    hydratum 834
  supercarbonas 830
  superphosphas 832
  tartras [illegible]
  tartarum 846
  valerianas [illegible]
Ferric tartrate of ammonia [illegible]
  potash [illegible]
Ferro-citrate of ammonia [illegible]
  tartrate of ammonia [illegible]
  potash [illegible]
Ferrum [illegible]
  ammoniatum [illegible]
  tartarizatum [illegible]
  [illegible]
[illegible]
Fever powder of Dr. James [illegible]
[illegible] 566
Fixed air 327
  nitre [illegible]
  [illegible]
Flake white 751
Flores [illegible] 726
  [illegible]
  [illegible] 845
  [illegible] 913
Flos [illegible]
Flowers of antimony 726
  arsenic [illegible]
Flowers of sulphur 551
  zinc 763
Fluor albus 551
  niger 551
Flux, black 551

Page
Flux, white 551
Fly powder [illegible]
Fomentations, warm 72
Food 62
Foods, animal 66
  vegetable 64
Forces, active, of medicines 89
  chemical 90
  dynamical 91
  physical 89
Fossil alkali 556
  salt 581
Fowler's solution 718
Freezing mixture 34
Frost bite 36
Fuller's earth 661
Fulminating gold 974
Fumigating pastiles 167
Fumigationes 166
  nitrosæ 166
Fuming sulphuric acid 364
Furnace cadmia 766

G.

Galena 782
Galvanism 51
Galvanic battery 53
  [illegible] 53
  current 55
  [illegible] 53
  [illegible] 55
Galvano-puncture 56
Ganglionica 221
Gargarisma calcis chlorinatæ 661
  sodæ chlorinatæ 596
Gargle of chloride of soda 596
Gas 327
  laughing 619
  nitrous 623
Gelatigenous principles 64
[illegible]
[illegible] 60
[illegible] 749
[illegible] 560
[illegible] 565
Glauber's salt 579
  secret sal ammoniac 670
  spirit of nitre 623
  salt 590
[illegible] 667
[illegible] 601
[illegible]
  [illegible] 974
  [illegible] 973
  [illegible] 976
  [illegible] 976
  [illegible] 975
  [illegible] 976
  [illegible] 977
  [illegible] 976
[illegible] 761
  [illegible]
  [illegible] 737
[illegible]
  [illegible] 664
Goulard's extract [illegible]
  water [illegible]
[illegible] 85
[illegible], for baths 72
[illegible] 510
[illegible] of mercury 919
Green vitriol 835
Griffith's mixture 879
Grotto del cane 73
[illegible] 72
Gum resins 790
Gymnastics 60

PAGE

H.

Hæmatica ... 172
Hæmatinica ... 193
Hahnemann's test liquor ... 377
Hair dyes ... 160
Hartshorn, burnt ... 626
Hartshorn, volatile salt of ... 457
Hearing ... 3
Heat ... 11
  animal ... 16
  conducted ... 15
  dry ... 15
  moist ... 17
  radiant ... 15
  solar ... 15
Helminthagoga ... 234
Hepar sulphuris ... 498
Hepatic air ... 375
Hepatica ... 238
Hepatised ammonia ... 465
Hydrotica ... 251
Homberg's pyrophorus ... 664
Homœopathia ... 125
Honey of borax ... 573
Hope ... 5
Horn silver, or luna cornea ... 959
Horse-hair gloves ... 4
Hume's test ... 689
Hydragoga ... 247
Hydrargyri acetas ... 954
  ammonio-chloridum ... 938
  bichloridum ... 929
  bicyanidum ... 946
  biniodidum ... 942
  bisulphuretum ... 914
  chloridum ... 919, 929
  cyanuretum ... 946
  dipernitras ... 950
  iodida ... 940
  iodidum ... 940
  murias corrosivus 929
  nitrates ... 949
  nitrico-oxydum ... 912
  nitro-oxydum ... 912
  oxydum cinereum ... 909
  oxydum ... 909
    nigrum ... 909
    rubrum 910
  oxydum sulphuricum ... 917
  oxymurias ... 929
  perchloridum ... 929
  percyanidum ... 946
  periodidum ... 942
  persulphas ... 918
  protonitras ... 949
  prussias ... 946
  subchloridum ... 919
  subiodidum viride ... 940
  submurias ammoniatum ... 938
  sub-sulphas flavus ... 917
  sulphates ... 917
  sulphuretum ... 914
  sulphuretum cum sulphure ... 916
  sulphuretum crystallizatum ... 914
    vel rubrum 914
  sulphuretum nigrum vel amorphum ... 916
Hydrargyrosis seu hydrargyriasis ... 687

PAGE

Iron, tannate of ... 859
- tartar of ... 864
- tartarised ... 864
- tartrate of potash and ... 864
- tincture of acetate of ... [illegible]
  - the muriate of ... 841
- valerianate of ... 860
- wine ... 867
- wire ... 818

Irrigation ... 33
Isomorphous compounds ... 84
Itch insect ... 355
Ivory black ... 322

J.

James's powder ... 727

K.

Kali aqua ... 494
- purum ... 486
- tartaricum stibiatum ... 741
- tartarised ... 548
- or vegetable alkali ... 489

Kalium ... 478
Kelp ... 548
Kermes mineral ... 734
Kirkland's neutral cerate ... 813
Klaprothium sulphuricum ... 778

L.

Labarraque's soda disinfecting liquid ... 590
Lac sulphuris ... 357
Lactate of iron ... 859
Lana philosophica ... 763
Lapides cancrorum præparati ... 622
Lapilli cancrorum præparati ... 622
Lapis calaminaris præparatus ... 768
- divinus ... 874
- infernalis ... [illegible]
  - vel septicus ... 486
- ophthalmicus ... 874

Laughing gas ... 619
Lavender ... 134
Laxatives, vegetable ... 249
Lead and its compounds ... 781
- acetate of ... 803
- black ... 318
- carbonate of ... 794
- chloride of ... [illegible]
- [illegible] ... [illegible]
- [illegible] ... [illegible]
- [illegible] ... 97
- iodide of ... [illegible]
- magistery of ... [illegible]
- neutral acetate of ... [illegible]
- nitrate of ... [illegible]
- orange ... 792
- oxide of ... 790
- phosphate of ... 792
- red oxide of ... 791
- saccharate of ... 813
- subcarbonate of ... 791
- sugar of ... [illegible]
- superacetate of ... [illegible]
- tannate of ... [illegible]
- white ... 79

PAGE

Ledoyen's disinfecting fluid ... 803
Leguminosæ ... 87
Lemery's white precipitate ... 938
Lemnian earth ... 661
Lemon and kali ... [illegible]
Lemon, essential salt of ... 555
Light ... 7
Lime ... 615
- bone-phosphate ... 626
- burned ... 615
- carbonates of ... 619
- chloride of ... 628
- hydrate of ... [illegible]
- hypochlorite of ... 631
- muriate of ... 628
- oil of ... 629
- oxymuriate of ... 631
- plumbate ... 791
- slaked ... 616
- superphosphate of ... 626
- triphosphate ... 625
- water ... [illegible]

Liniment of ammonia ... 465
- mercury ... 908
- sesquicarbonate of ammonia ... 457
- soap ... [illegible]
- volatile ... 465

Linimentum æruginis ... 879
- ammoniæ ... 465
  - compositum ... 465
  - sesquicarbonatis ... 457
- calcis ... [illegible]
- hydrargyri ... [illegible]
- saponis ... [illegible]

Liqueur d'ammoniaque ... 446
Liqueur de Labarraque ... 590
Liquefacients ... 179
Liquid oxymuriatic acid ... [illegible]
Liquids, warm ... 20
Liquor acidi arseniosi hydrochloricus ... 719
- aluminis compositus ... [illegible]
- ammoniæ ... 437
  - acetatis ... 471
  - fortior ... 439
  - sesquicarbonatis ... 457
- antimonii terchloridi ... 761
- [illegible] ... 870
- argenti nitratis ... 971
- arsenicalis ... 718
- barii chloridi ... 616
- Boyle's fuming ... 463
- calcii chloridi ... 630
- calcis ... 612
  - chlorinatæ ... 630
- chlorinei recens præparatus ... 590
- cupri ammonio-sulphatis ... 877
- hydrargyri bichloridi ... 917
  - [illegible] arseniatis ... 964
  - [illegible] ... 931
- [illegible] arsenici et hydrargyri ... 964
- magnesiæ citratis ... [illegible]
- plumbi diacetatis ... [illegible]
  - dilutus ... [illegible]
  - subacetatis ... [illegible]
- potassæ ... 486
  - arsenitis ... [illegible]
  - carbonatis ... 490
  - citratis ... [illegible]
  - effervescens ... 556
  - effervescens ... [illegible]
- potassii iodidi compositus ... 523
- [illegible] ... 533
- sodæ ... 536
  - chlorinatæ ... 590
  - effervescens ... [illegible]

PAGE

Liquor stibii chlorati ... 760
- tartari emetici ... 758
- zinci chloridi ... 775

Litharge, or silver stone ... 790
- gold or silver ... 790

Lithargyrum ... 790
Lithiæ carbonas ... 606
Lithica ... [illegible]
Lithonlytica ... 264
Lithontriptica ... 264
Liver of sulphur ... 498
Lixivium saponarium ... 486
- tartari ... 496

Lixiviæ cineres ... 489
Lobeliaceæ ... 87
Lolium temulentum ... 85
Lotio ammoniæ hydrochloratis ... 465
- calcis chlorinatæ ... 641
- flava ... 912
- nigra ... 910
- phagedænica ... 912
- sodæ chlorinatæ ... 591

Lozenges, magnesia ... 656
- soda ... 549

Lugol's caustic, rubefacient, and [illegible] ... 523
- concentrated [illegible] ... 523
- saturated [illegible] ... 523
  - mineral water ... 523

Luna cornea ... 959
Lunar caustic ... 961

M.

Machines, coil ... 55
- electric ... 30
- electro-dynamic ... 34
- induction ... 36
- magneto-electric ... 36
- voltaic electric ... 34

Magistery of bismuth ... 791
Magistery of [illegible] ... [illegible]
- [illegible] ... 793

Magnesia ... 642
- alba ... 647
- [illegible] ... 656
- calcined ... 642
  - ponderosa ... 644
  - [illegible] ... 642
- [illegible] ... 642
- carbonate of ... 647
- citrate of ... [illegible]
- [illegible] ... 644
- [illegible] ... [illegible]
- [illegible] ... 654
- [illegible] ... 644
  - [illegible] ... 649
- [illegible] ... 644
- [illegible] ... 649
- [illegible] ... 649
- [illegible] ... 654
- [illegible] ... [illegible]
- [illegible] ... [illegible]
- [illegible] ... [illegible]
- [illegible] ... [illegible]
- [illegible] ... 656
  - [illegible] saturated ... 656

Magnesiæ carbonas ... 654
- [illegible] ... 647
- [illegible] ... 649
- [illegible] ... 655
- tartras ... 660

Magnesian [illegible] ... [illegible]
Magnesite ... [illegible]

PAGE
- Magnesium, compounds of.. 642
  - oxide of........ 642
- Magnetic electricity 56
  - iron pyrites 814
  - oxide of iron...... 820
  - oxygen 59
- Magnetism 58
- Magneto-electric machines.. 58
- Magnets.................... 61
  - electro 57
  - temporary 57
- Manganese 674
  - acetate of 680
  - binoxide of...... 674
  - carbonate of 676
    - saccharine 677
  - chloride of 679
  - native black, or peroxide of.... 674
  - sulphate of...... 677
  - therapeutic action of 678
- Manganesii acetas 680
  - binoxydum 674
  - carbonas........ 676
  - chloridum 679
  - oxydum 674
  - sulphas 677
- Manna metallorum.......... 919
- Manuluvium................ 21
- Marble 621
- Marbled soap 602
- Marcasita.................. 757
- Marine acid 387
- Marmor 621
  - album.............. 621
- Mars, salts of 835
  - vitriol of.............. 835
- Marsh's test 691
- Martial Ethiops 820
- Massicot.................... 790
- Massing 18
- Masticatoria 254
- Materia hermaphrodita...... 213
  - Medica 1
- Meconica 206
- Mechanical antidotes........ 158
- Medicamenta emollientia.... 170
- Medicines 82
  - absorption of 103
  - acting dynamically on the blood 199
  - acting on the nervous system 203
  - acting on the respiratory organs .. 199
  - active forces of .. 89
  - changes in, by the action of the organism 91
  - chemical effects of 96
    - properties of 87
  - circumstances which modify the effects of........ 119
  - classifications of .. 137
  - endosmotic effects of 94
  - injection of, into the veins 136
  - modes of ascertaining the effects of 83
  - operation of, by nervous agency . 117
  - parts to which they are applied...... 130
  - physical effects of . 94
  - physiological classes of 158
    - effects of 93
  - remote effects of .. 102
  - therapeutical effects 123

PAGE
- Medicines, tolerance of...... 102
  - topical 158
- Mel ægyptiacum 879
  - boracis 573
- Melinum 778
- Mellite of borax 573
- Menagoga 269
- Mephitic air................ 418
- Mercurial balsam 952
  - candles 896
  - compounds 880
  - disease 887
  - erethism.......... 888
  - fever.............. 888
  - ointment.......... 905
  - pills 904
  - plaster............ 908
  - purging 889
- Mercurialia 188
  - et antimonialia.. 188
- Mercurius alcalisatus 903
  - cosmeticus........ 938
  - dulcis 919
  - præcipitatus ruber 912
    - ruber per se 910
  - sublimatus corrosivus 929
- Mercury and its compounds . 880
  - acetate of.......... 954
  - ammonio-chloride of 938
  - ammoniated 938
    - submuriate of.... 938
  - bibasic nitrate of the oxide of.......... 950
  - bipersulphate of.... 918
  - bisulphuret of...... 914
  - black oxide of...... 909
    - sulphuret of.. 916
  - calcined 910
  - chloride of 919, 929
  - coagulated 910
  - corneous 919
  - corrosive muriate of 929
  - cyanide of 946
  - deutiodide of 942
  - green subiodide of.. 940
  - grey oxide of 909
  - hydrochlorate of .. 929
  - iodides of.......... 940
  - metallic 884, 894
  - muriate of 929
  - nitrates of.......... 949
  - nitric oxide of...... 912
  - of life.............. 724
  - ointment of........ 905
    - iodide of 941
    - nitrate of 952
  - oxide of............ 909
  - oxymuriate of...... 929
  - perchloride of...... 929
  - percyanide 946
  - periodide of........ 942
  - peroxide of 910
  - persulphate of 918
  - pills of 904
  - plaster of.......... 908
  - preparations of 895
  - protochloride of.... 919
  - protiodide of 940
  - purified............ 902
  - red oxide of........ 910
    - precipitated.... 912
  - subchloride of 919
  - submuriate of...... 919
  - suboxide of........ 909
  - sulphates of........ 917
  - sulphuret of 914
  - theory of the action of................ 892
  - white precipitated.. 938
  - with chalk 903
    - magnesia 904

- Mercury, yellow subsulphat
- Metalloids ....
- Method by ingestion.......
  - endermic ....
  - enepidermic ......
  - intraleptic.........
- Methystica ....
- Mild mineral or fossil alkal
  - vegetable alkali.......
- Milk of sulphur ....
- Mind, external affections of.
  - internal affections of.
- Mindereri liquor............
- Mineral, æthiops............
  - kermes............
  - solution...........
  - springs, table of....
  - turpeth...........
  - waters ....
- Minium....................79
  - secundarium........
- Mistura cretæ ....
  - ferri aromatica ....
    - composita......
  - Griffithii..........
- Mixture, freezing ....
- Molybdæna ....
- Monotony ....
- Morbus Brightii ....
- Mosaic gold ....
- Mud bathing................
- Mundic ....
- Murias ammoniæ............
  - barytæ ....
  - hydrargyri corrosivus
  - sodæ ....
- Muriate of ammonia and mercury............
  - antimony ....
  - barytes ....
  - iron, tincture of..
  - lime ....
  - mercury ....
  - soda ....
  - zinc..............
- Muriatic acid ....
  - gas ....
- Muriatis ferri liquor ....
- Muride ....
- Music......................

N.

- Narcotic salt................
- Narcotica ....
- Natron carbonicum perfecte saturatum seu acidulatum..........
  - vitriolatum ....
- Natrum carbonicum ....
- Natrium....................
  - oxide of ....
- Nauseantia ....
- Neurotica ....
- Neutral ointment ....
- Nicotiana ....
- Nihil album ....
- Nitraria artificial............
- Nitras argenti ....
  - hydrargyricus acido nitrico solutus........
  - potassæ ....
- Nitrate of ammonia ....
  - lead ....
  - potash............
  - silver ....
- Nitrates in water ....

PAGE
Nitrières, artificial 538
Nitre 535
  beds 539
  fixed 489
  walls 539
Nitric acid 422
  oxide 422
    of mercury 912
Nitrogen 418
  deutoxide of 422
  in food 63
  protoxide of 419
Nitrogenii binoxydum 422
  protoxydum 419
Nitrogenium 418
Nitro-hydrochloric acid 432
  muriatic acid 432
    bath 433
    oxide of antimony 724
Nitrous acid 426
  gas 422
  oxide 419
Nitrum 535
  flammans 470
  saturninum 801
  semivolatile 470
  tabulatum, or sal prunelle 540
Non-naturals 62
Nordhausen, fuming sulphuric acid of 364

O.

Odoraments 2
Od 60
Oil, carron 619
  Chabert's 238
  of antimony 740
    iron 841
    lime 629
    vitriol 359
  or butter of antimony 740
Oils 226
  non-oxygenated 226
  non-sulphurated 226
  oxygenated essential 226
  sulphurated volatile 225
  volatile 225
Ointment, arsenical 721
  blue, or Neapolitan 905
  citrine 952
  mercurial 905
  neutral 813
  of ammonia 446
Oleo-margarate of lime 619
  resinæ 228
Olera 227
Oleum calcis 629
  empyreumaticum Chaberti 238
  phosphoratum 346
  seu butyrum antimonii 740
  sulphuratum 358
Olive, refuse of, for baths 22
  oil 811
Opium and calomel pills 928
Opodeldoc 605
Orpiment 722
Ossa deusta alba 626
  calcinata 626
Ostrea edulis 622
Oxalate of ammonia 474
Oxide, nitric 422
  nitrous 419
  of arsenic 682
    calcium 615

PAGE
Oxide of lead 790
    manganese 674
    mercury 909
    silver 957
    zinc 763
Oxiodine 412
Oxy.chloride of antimony 724
Oxydi ferri squamæ 821
Oxydum antimonii nitro-muriaticum 724
  ferroso ferricum 820
  ferri nigrum 820
    rubrum 822
  hydrargyri cinereum 909
    rubrum 910
  plumbi semivitreum 790
  zinci 763
    impurum 766
Oxygen 272
  water 277
Oxygenated muriatic acid 379
Oxygenised fat 431
  water 277
Oxygenium 272
Oxymel æruginis 879
  cupri subacetatis 879
Oxymuriate of potash 509
  soda 589
Oyster shell, prepared 622
Ozone 71, 277

P.

Panchymagogum minerale 919
Pancreatica 239
Paralytica 217
Pasta arsenicalis 721
  escharotica Londinensis 488
Pâtés de foies gras 12
Pearlash 489
  white 758
Pernitrate of iron 856
Peroxide of gold 974
  manganese 674
  mercury 910
Persulphate of iron 840
Pharmocognosy 82
Pharmaco-dynamics 83
Pharmacology 82
Pharmacology, general 83
  special 271
Pharmacy 82
Philosopher's wool 763
Phlogisticated air 418
Phosphas, sodæ 574
Phosphate of lime, precipitated 627
  soda 574
Phosphorated oil 346
Phosphoric acid 346
Phosphorised oil 346
Phosphorus 231, 340
  allotropic or amorphous 231
Phrenica 204
Physagoga 224
Piline, impermeable spongio 22
Pills, blue 904
  Plummer's 739, 928
Pilulæ asiaticæ 721
  cæruleæ 904
  calomelanos compositæ 928
  calomelanos et opii 928
  catharticæ compositæ 929
  cupri ammoniati 877
  ferri carbonatis 830

PAGE
Pilulæ ferri compositæ 830
    cum myrrhâ 830
    iodidi 852
    sulphatis 839
  hydrargyri 904
    chloridi compositæ 928
  plumbi opiatæ 808
Plaster, adhesive 606, 812
  of ammoniacum with mercury 909
    lead 811
    mercury 908
  resin 812
  soap 605
  strengthening 824
Platini bichloridum 977
Platino bichloride of sodium 978
Platinum, compounds of 977
Plumbago 318
Plumbi acetas 803
  carbonas 793
  chloridum 797
  diacetas 808
  diacetatis solutio 809
  iodidum 799
  nitras 801
  oxydum 790
    rubrum 791
    semivitreum 790
  saccharas 813
  subacetatis liquor 809
    compositus 810
  superacetas 803
  tannas 813
Plumbite of lime 791
Plumbum 781
  nitricum 801
Plummer's pill 928
Pneumatica 199
Poisons and reputed antidotes 164
Pommade d'Alyon 431
  ammoniacale de Gondret 446
Pompholyx 763
Potash 478
  acetate of 546
  acidulous tartrate of 550
  antimony, tartrate of 741
  bicarbonate of 494
  binoxalate of 554
  bisulphate of 506
  bitartrate of 550
  borate of 573
  boro-tartrate of 553
  carbonates of 488
  caustic 486
  chlorate of 509
  citrate of 553
  hydrate of 486
  hydriodate of 513
  hydrobromate of 524
  hypochlorite of 508
  iodide of 513
  neutral arsenite of 719
  neutral or bibasic tartrate of 548
  neutral carbonate of 488
    sulphate of 502
  nitrate of 535
  oxalates of 554
  oxymuriate of 509
  permanganate of 680
  pure carbonate of 490
  quadroxalate of 555
  refined 490
  saltpetre 535
  soap 603
  solution of 484
  subcarbonate of 489
  sulphates of 502
  sulphuret of 498

PAGE

- Potash, supersulphate of 506
  - supertartrate of 550
  - tartrate of soda and 597
  - the acid or monobasic tartrate of 550
  - water 497
- Potashes and pearlashes 489
- Potassa 478
  - caustica 486
  - cum calce 488
  - fusa 489
  - impura 486
- Potassæ acetas 546
  - aqua 484
    - effervescens 497
  - bicarbonas 494
  - bisulphas 506
  - bitartras 550
  - boro-tartras 553
  - carbonas 488
  - carbonates 488
  - carbonatis aqua 494
  - causticæ aqua 484
  - chloras 509
  - chromates 672
  - citras 553
  - et sodæ tartras 597
  - hydras 486
  - hydriodas 513
  - hypochloris 508
  - monocarbonas 488
  - monosulphas 502
  - monoxalas 554
  - nitras 535
  - oxalates 554
  - permanganas 680
  - quadroxalas 555
  - sesquisulphas 505
  - sodio-tartras 597
  - sulphas 502
  - sulphates 502
  - sulphureti aqua 501
  - sulphuretum 498
  - supertartras 550
  - tartras 518
  - tartras acida 550
  - tartrates 548
- Potassii bromidum 524
  - et hydrargyri iodocyanidum 949
  - ferridcyanidum 534
  - iodidum 513
  - sulphuretum 498
  - tersulphuretum 498
- Potassio-sulphate of peroxide of iron 671
  - tartras antimonii 741
- Potassium 478
  - bromide of 524
  - chloride of 508
  - cyanidum 527
  - ferridcyanide 534
  - hydrobromate of 524
  - iodide of 513
  - ioduret of 513
  - iodurretted iodide 515
  - protoxide of 478
  - sulphuret of 498
  - tersulphuret of 498
- Pot herbs 227
- Potus imperialis 553
- Poudre subtile 722
- Poultice, charcoal 322
  - emollient 22
  - substitute for 22
- Powder, antimonial 727
  - Dr. James's 727
  - of antimony, compound 727
  - of Algaroth 724
  - Tennant's bleaching 631
- Powders, ginger-beer 568

PAGE

- Powders, Seidlitz 568
  - soda 568
- Precipitate, red 912
  - white 938
- Precipitated phosphate of lime 627
- Preston salts 450
- Prismatic nitre 535
- Proteine 63
- Protiodide of mercury 940
- Protochloride of mercury 919
- Protoxide of hydrogen 282
  - nitrogen 419
  - potassium 478
- Prussian blue 852
- Psammismus 16
- Ptarmica 240
- Ptyalagoga 254
- Pulveres effervescentes 568
  - sedlitzenses 568
- Pulvis aluminis compositus 670
  - antimonii compositus 727
  - antimonialis 727
  - auri 973
  - cornu cervini usti 626
  - cretæ compositus 624
  - escharotica arsenicalis 721
  - febrifugus Jacobi 727
  - ferri 818
  - salinus compositus 659
  - stanni 780
- Pumping 32
- Purgativa 247
- Purgatives 159
  - mechanical 159
- Purging saline waters 311
- Purple of Cassius 974
- Purpura mineralis Cassii 974
- Pyrites, cockscomb 833
- Pyrophosphate of soda 575
- Pyrrhin 477

Q.

- Quevenne's iron 819
- Quicklime 615
- Quicksilver 880

R.

- Realgar 721
- Reasoning 7
- Red antimony 734
  - Armenian bole 661
  - arsenic 721
  - lead 791
  - oxide of lead 791
    - mercury 910
  - or peroxide of iron 822
  - precipitate 912
    - per se 910
  - zinc 761
- Refrigerants 174
- Relaxantia deprimentia 216
- Remedies, hygienic 62
  - mechanical and surgical 82
  - pharmacological 82
  - physical but imponderable 7
  - psychical or mental 2
  - somatical or corporal 2
- Removal from home 6
- Repellents 163
- Repercussives 163
- Reprimentia 260

- Resinosa
- Resolventia
- Restraint
- Reussite
- Revulsion and derivatio
- Rex metallorum
- Rhombic phosphate of s
- Roche alum
- Rochelle salt
- Roman alum
  - vitriol
- Rouge
- Rubefacients
- Rubigo ferri
- Rust of copper
  - iron

S.

- Saburration
- Saccharate of lead
- Saccharum aluminatum
  - saturni
- Sal absinthii
  - ammoniac
    - fixed
    - Glauber's
    - cret
    - plaster
  - ammoniacus
  - acetosellæ
  - anglicum
  - auri philosophicum
  - catharticum
  - catharticus Glauberi
  - de duobus
    - Seignette
  - enixum
  - fossilis, or sal gemma
  - martis
  - mirabile Glauberi
    - perlatum
  - polychrest
  - polychrestum Glaseri
    - Seignet
  - Rupellensis
  - sedativum Hombergi
  - Seidlitzense
  - tartari
  - vitrioli
  - volatile
    - cornu cervi
- Salads
- Salia neutra et media
- Saline waters
- Salix
  - Russelliana
- Salt alkali
  - alkaline
  - baker's
  - bitter purging
  - black
  - common
  - culinary
  - diuretic
  - Epsom
  - fossil
  - Glauber's
  - hair
  - of lemons
    - Mars
    - Seignette
    - tartar
    - wood sorrel
    - wormwood
- Salt or brine waters
  - Rochelle
  - sedative or narcotic

PAGE
Stimuli, diffusible 222
  heterogeneous....... 99
  homogeneous 99
  vital.................8, 99
  vivifying 99
Stomachics 224
Stone 262
  divine 874
  the infernal 961
Strengthening plaster 824
Stupefacients 204
Styptics 162
Subacetate of copper 877
Subcarbonate of ammonia .. 451
    potash 489
Subchloride of mercury 919
Suboxide of mercury 909
Sublimatus corrosivus 929
Submuriate of mercury....... 919
Subphosphate of lime 626
Subsulphas hydrargyri flavus 917
Sudatorium 16
Sudorifica 251
Sudorifics or diaphoretics.... 251
Sugar of lead.................. 803
Sulphas aluminæ et potassæ . 662
  ammoniæ 470
  ferri.................. 835
    exsiccatum 839
  magnesiæ 655
  potassæ 502
  sodæ.................. 579
  zinci.................. 769
Sulphate of ammonia......... 470
  baryta 609
  copper 871
  iron 835
  magnesia......... 655
  oxide of ammonium........... 470
  potash 502
  soda 579
  zinc 769
Sulphated chalybeates 307
Sulphates of potash 502
Sulphide of carbon 377
Sulphis sodæ sulphuratus .. 577
Sulphur 350
  alcohol of 377
  allotropic 353
  antimoniatum fuscum 737
  antimonii auratum .. 739
  balsam of 358
  Boyle's fuming liquor of 468
  caballinum 359
  carburet of.......... 377
  common native 350
  crudum 351
  flowers of 356
  griseum 359
  hydrate of 357
  iodide of 413
  liver of............... 498
  lotum 356
  milk of 357
  native or virgin 350
  nigrum 359
  oil of.................. 468
  ointment of 358
    compound . 358
    the iodide of 414
  præcipitatum 357
  precipitated 357
  refined................ 352
  roll, stick, or cane .. 353
  sublimatum 356
  sublimed.............. 356
  vivum 359
  volatile tincture of .. 469
  volcanic 350
  washed 356

PAGE
Unguentum ammoniæ 446
  antimoniale 756
  antimonii potassio-tartratis .. 756
  arsenici 721
  calaminæ 768
  calcis chlorinatæ 642
  citrinum 952
  cupri subacetatis 879
  hydrargyri 905
    ammonio-chloridi 940
      submuriatis ammoniati 940
    biniodidi 944
    chloridi 928
    iodidi rubri 944
    nitratis 952
      mitius.. 954
    nitrico-oxydi .. 914
    oxydi nitrici.... 914
    iodinii 412
    iodinii compositum 522, 412
  oxydi hydrargyri 914
  plumbi acetatis 808
    carbonatis .. 797
    compositum 813
    iodidi 801
    tannatis 814
  potassæ hydriodatis.......... 521
  potassii bromidi 527
    iodidi.. 522
  præcipitati albi.. 940
  saturninum 808
  sulphuris 358
    compositum 358
    iodidi 414
  tartari emetici.. 756
  zinci............ 766
    oxydi...... 766
Upas, Guevo................ 72
Uretica 256
Urinalia.................... 256
Uterina 269

V.

Valerianate of iron.......... 860
  soda 597
  zinc.......... 777
Vapour, aqueous............ 17
  bath................ 17
  douche 19
  inhalation of warm.. 19
Vegetable alkali 478
  mild ...., 489
  salt 548
Verdigris 877
  distilled or crystallized 880
  ointment of 879
  prepared.......... 879
Vermicides 237
Vermifuga.................. 234
Vermilion 914
Vesicants 169
Vinum antimonii 756
  antimonii potassio-tartratis 756
Vinum ferri 867
Virgin sulphur.............. 350

PAGE
Vision...................... 4
Vital air.................... 272
Vitriolated iron 835
  kali 502
  magnesia 655
  tartar 502
Vitriol, blue 871
  elixir 373
  green 835
  of Mars 835
  oil of 359
  Roman 871
  spirit of 372
  white 769
Vitrioli, sal 769
Vitriolum cæruleum 871
  Martis 835
  viride........... 835
Vitrum antimonii 726, 742
Volatile alkali 433
  liniment............ 445
  salt of hartshorn.... 457
Volcanic sulphur............ 350
Volta-electric machines 56
Voltaic alternatives 43
  battery 53
  current 55
  electricity 53
  shock 55
Voltaism 53
Vomitoria 243

W.

Wash, black 910
  yellow................ 912
Washed sulphur 356
Washes 33
Water 282
  boiling 23
  cure................ 34
  distilled 288
  dressing.............. 287
  hard.................. 293
  hydrogen 282
  lake 301
  lime.................. 619
  marsh 301
  of ammonia 437
    Ascot Heath 782
    the Dead Sea 301
  oxygen 277
  rain 297
  river 299
  sea 301
  seltzer 333
  snow 298
  soda..........333, 569, 831
  solutive 422
  spring................ 298
  Webb's soda.......... 569
  well 298
Waters 296
  acidulous or carbonated 309
  acidulo-alkaline 309
  alkaline 313
  aluminous chalybeate 307
  artificial mineral...... 316
  calcareous 312
  carbonated chalybeates 307
  chalybeate, or ferruginous 305

PAGE
Waters common 290
  distilled 289
  medicated 289
  mineral 303
  natural aluminous 668
  pure natural.......... 291
  purging saline........ 311
  saline 311
  salt or brine.......... 312
  siliceous.............. 313
  sulphated chalybeate.. 307
  sulphureous, or hepatic 308
Wells, artesian 299
  London 298
White arsenic 682
  copperas 769
  flake................ 793
  flux.................. 551
  iron pyrites.... 833
  lead 793
  oxide of mercury 938
  pearl 758
  precipitate 938
  precipitated mercury 938
  Spanish.............. 758
  vitriol................ 769
Willow 320
Wine antimonial............ 756
  of iron 867
  steel.................. 867
Witherite 608
Wood ashes 321
  charcoal.............. 320

Y.

Yellow arsenic.............. 722
  ointment 952
  sulphate of mercury.. 917
  wash 912

Z.

Zinc and its compounds 761
  acetate of.............. 776
  butter of 772
  carbonate of 768
  chloride of 772
  cyanide of 777
  flowers or calx of 763
  hydrochlorate of 772
  impure oxide of........ 766
  muriate of 772
  ointment 766
  oxide of................ 763
  red 761
  silicate of.............. 768
  sulphate of 769
  valerianate of.......... 777
Zinci acetas 776
  carbonas.............. 768
    impura 766
    impurum præparatum .. 768
  chloridum 772
  cyanidnm 777
  oxydum 763
    impurum 766
  sulphas 769
  valerianas 777
Zincum 761

NEW WORKS IN

MEDICAL, SURGICAL, SCIENTIFIC, & GENERAL LITERATURE.

	£.	s.	d.
Miss Acton's Modern Cookery Book, fcp. 8vo. Plates, &c.	0	7	6
Adams's Anatomy and Diseases of the Prostate Gland, 8vo.	0	5	0
Ancell's Treatise on Tuberculosis, 8vo.	1	1	0
Annesley's Researches on the Diseases of India, 8vo.	0	12	0
The Artisan Club's Treatise on the Steam Engine, 4to.	1	7	0
Balman On Scrofulous Diseases of the External Lymphatic Glands, 8vo.	0	7	6
Beck's Elements of Medical Jurisprudence, 8vo.	1	1	0
Bird's Lectures on Electricity and Galvanism, fcp. 8vo.	0	5	6
Birkett On Diseases of the Breast and Mammary Gland, 8vo.	0	12	6
Black's Practical Treatise on Brewing, 8vo.	0	10	0
Blaine's Canine Pathology, by Mayer, 8vo.	0	7	6
——— Compendium of the Veterinary Art, New Edition, by Mayhew, 8vo.	1	4	0
Blair and Davy on the Yellow Fever of Guiana, 8vo.	1	1	0
Bowman's Lectures on the Parts concerned in Operations on the Eye, 8vo.	0	6	0
Brande's Dictionary of Science, Literature, and Art, 8vo.	3	0	0
Brewster's Treatise on Optics, fcp. 8vo.	0	3	6
Brodie's Lectures Illustrative of Pathology and Surgery, 8vo.	0	12	0
——— Physiological Researches, 8vo.	0	6	0
——— Observations on Diseases of the Joints, 8vo.	0	10	6
——— Lectures on Diseases of the Urinary Organs, 8vo.	0	12	0
Bull's Hints to Mothers (Pregnancy, Lying-in, &c.), fcp. 8vo.	0	5	0
——— Maternal Management of Children, fcp. 8vo.	0	5	0
Burrows On Disorders of the Cerebral Circulation, 8vo.	0	10	6
Catlow's Popular Conchology, New Edition, post 8vo. with 405 Woodcuts	0	14	0
Conquest's Outlines of Midwifery, edited by Dr. J. M. Winn, fcp. 8vo. Woodcuts	0	8	6
Cooper's First Lines of Surgery, 8vo.	0	18	0
——— Surgical Dictionary, 8vo.	1	10	0
Copland's Medical Dictionary, Vols. I. and II. 8vo. each	1	10	0
Cust's (Lady) Invalid's Own Book, fcp. 8vo.	0	3	6
De La Rive's Treatise on Electricity, Vol. I. 8vo.	0	18	0
Donovan's Treatise on Chemistry, fcp. 8vo.	0	3	6
——— Domestic Economy, 2 vols. fcp. 8vo.	0	7	0
Elliotson's Human Physiology, 8vo.	2	2	0
Faraday's Lectures on the Non-Metallic Elements, by Dr. Scoffern, fcp. 8vo.	0	5	6
Field's Veterinary Records, 8vo.	0	8	0
Henslow's Descriptive and Physiological Botany, fcp. 8vo.	0	3	6
Herschel's Preliminary Discourse on Natural Philosophy, fcp. 8vo.	0	3	6
——— Treatise on Astronomy, fcp. 8vo.	0	3	6
——— Outlines of Astronomy, with Plates, &c. 8vo.	0	18	0
Holland's (Sir H.) Chapters on Mental Physiology, 8vo.	0	10	6
——— Medical Notes and Reflections, 8vo.	0	18	0
——— (J.) Treatise on Manufactures in Metal, 3 vols. fcp. 8vo.	0	10	6
Hooker's (Sir W. J.) Kew Guide, 16mo.	0	0	6
——— British Flora, 12mo. 14s. plain, or with coloured Plates	1	1	0
Hooper's Medical Dictionary, by Dr. Klein Grant, 8vo.	1	10	0
Hughes (Dr. H. M.) Clinical Introduction to the Practice of Auscultation, fcp. 8vo.	0	6	6
Humboldt's Cosmos, translated by Sabine, 2 vols. 16mo. 5s., or 2 vols. post 8vo.	1	4	0
——— Vol. III. 16mo. Part I. 2s. 6d. Part II. 3s. or post 8vo. Vol. III. complete	0	12	6
——— Aspects of Nature, translated by Sabine, 16mo.	0	6	0
Hunt's Researches on Light, 8vo.	0	10	6
Kater and Lardner's Treatise on Mechanics, fcp. 8vo.	0	3	6
Kemp's Natural History of Creation, 16mo.	0	1	0
——— Indications of Instinct, 16mo.	0	1	0
Lardner's Treatise on Heat, fcp. 8vo.	0	3	6
——— Hydrostatics and Pneumatics, fcp. 8vo.	0	3	6
——— and Walker's Electricity, Magnetism, and Meteorology, 2 vols. fcp. 8vo.	0	7	0
Latham On Diseases of the Heart, 2 vols. 12mo.	0	16	0
Lee's (Dr. R.) Lectures on Midwifery, 8vo.	0	15	0

London: Longman, Brown, Green, and Longmans.

NEW WORKS IN

MEDICAL, SURGICAL, SCIENTIFIC, & GENERAL LITER

Lee's (Mrs. R.) Elements of Natural History, fcp. 8vo.
Lindley's Introduction to Botany, 2 vols. 8vo.
——— Theory of Horticulture, New Edition, 8vo. *Preparing f*
Little (Dr. W.) On the Nature and Treatment of Deformities, 8vo.
Loudon's Encyclopædia of Plants, New Edition, 8vo.
Mackenzie's Treatise on Diseases of the Eye, New Edition, 8vo.
Marcet's Conversations on Chemistry, 2 vols. fcp. 8vo.
——— ——— ——— Natural Philosophy, fcp. 8vo.
——— ——— ——— Vegetable Physiology, fcp. 8vo.
Matteucci's Lectures on the Physical Phenomena of Living Beings, translated under the Sup
intendence of Dr. Pereira, post 8vo.
Maunder's Scientific and Literary Treasury, fcp. 8vo.
Montgomery's Exposition of the Signs & Symptoms of Pregnancy, New Edit. 8vo.—*Preparing f*
Moore's (Dr. G.) Man and his Motives, fcp. 8vo.
——— ———Power of the Soul over the Body, fcp. 8vo.
——— ———Use of the Body in relation to the Mind, fcp. 8vo.
——— ———Health, Disease, and Remedy, post 8vo.
Nevins's Translation of the New London Pharmacopœia, post 8vo.
Owen's Lectures on the Comparative Anatomy and Physiology of Vertebrate Animals, Vol. I. 8
Paget's Lectures on Surgical Pathology, 2 vols. 8vo.
——— ——— Tumours, 8vo.
Percivall's Anatomy of the Horse, 8vo.
——— Diseases of the Chest and Air-Passages of the Horse, 8vo.
——— Lameness in the Horse, 8vo.
———Twelve Lectures on the Form and Action of the Horse, 8vo.
Pereira's Treatise on Food and Diet, 8vo.
——— Materia Medica, Vol. I. 8vo.
——— ——— ——— Vol. II. Part I. 8vo.
——— ——— ——— Vol. II. Part II. 8vo.
Peschel's Elements of Physics, 3 vols. fcp. 8vo.
Phillips's Treatise on Geology, 2 vols. fcp. 8vo.
——— Introduction to Mineralogy, post 8vo.
Psychological Inquiries, fcp. 8vo.
Rees (Dr. G. O.) On the Analysis of the Blood and Urine, 8vo.
——— ——— On Diseases of the Kidney, 8vo.
Seymour (Dr. E.) On the Nature and Treatment of Severe Diseases, 8vo.
Smee's Elements of Electro-Metallurgy, post 8vo.
Solly on the Human Brain, 8vo.
Stanley's Treatise on Diseases of the Bones, 8vo. with folio Atlas of Plates
——— the Treatise separately
Swan's Plates of the Brain, in Explanation of the Nervous System, 4to.
Tamplin's Lectures on Deformities, fcp. 8vo.
Teale's Practical Treatise on Abdominal Hernia, 8vo.
Thomas's Modern Practice of Physic, New and greatly improved Edition, 2 vols. 8vo.
Thomson's (Dr. A. T.) Conspectus of the Pharmacopœias, 18mo.
——— ——— ——— ——— ——— with tuck, as a pocket-book
——— ——— ——— London Dispensatory, corrected by Dr. A. B. Garrod, 8vo.
——— (Dr. R. D.) School Chemistry, fcp. 8vo.
Todd's Cyclopædia of Anatomy and Physiology, 8vo. Vol. I. £2.; Vol. II. £2. 10s.; Vol II
£2. 10s.; Vol. IV. £3. 10s.—Supplement, in course of publication in Parts, each
*** Subscribers to Todd's *Cyclopædia of Anatomy and Physiology* are requested to comple
their Sets, as the sale of separate Parts in the body of the work will be shortly discontinued.
Travers's Observations in Surgery, 8vo.
Ure's Dictionary of Arts, Manufactures, and Mines, 2 vols. 8vo.
West's Lectures on the Diseases of Infancy and Childhood, 8vo.
White's Compendium of the Veterinary Art, 8vo.
——— ——— Cattle Medicine, 8vo.
Wilson's (Erasmus) Dissector's Manual of Practical and Surgical Anatomy, 12mo.
——— (Dr. G.) Electricity and the Electric Telegraph, 18mo.

London: LONGMAN, BROWN, GREEN, and LONGMAN

LANE MEDICA

To avoid fine, this book
or before the date l

U141 Pereira, J. [illegible]
P43 The elements of
v.1 materia medica and
1854 therapeutics.

ATTIC